

C07K 14/525
BR 9401321
FI 941459
IL00 109094

AU 5901994
CA 2119089
HU00 9400829
NO 941142



Publication number: **0 619 372 A1**

(12)

EUROPEAN PATENT APPLICATION

(21) Application number: 94104154.3

(51) Int. Cl.⁵: **C12N 15/28**, C12P 21/02,
C07K 13/00, A61K 37/02,
G01N 33/68, C12N 1/21

(22) Date of filing: 17.03.94

(30) Priority: 29.03.93 EP 93810224

(43) Date of publication of application:
12.10.94 Bulletin 94/41

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC
NL PT SE

(71) Applicant: F. HOFFMANN-LA ROCHE & CO.
Aktiengesellschaft
Postfach 3255
CH-4002 Basel (CH)

(72) Inventor: Banner, David
129 Neubadstrasse

CH-4054 Basle (CH)
Inventor: Lesslauer, Werner
288 Auessere Baselstrasse
CH-4125 Riehen (CH)
Inventor: Lötscher, Hansruedi
18 Frankenstrasse
CH-4313 Möhlin (CH)
Inventor: Stüber, Dietrich
9 Bandweg
D-79639 Grenzach-Wyhlen (DE)

(74) Representative: Mezger, Wolfgang, Dr. et al
Grenzacherstrasse 124
Postfach 3255
CH-4002 Basel (CH)

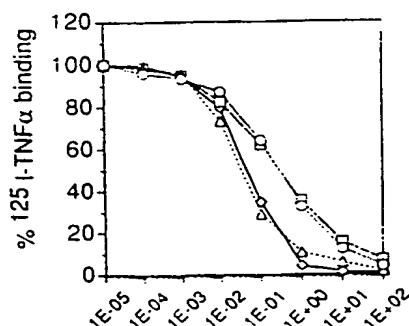
(54) Tumor necrosis factor muteins.

(57) Human TNF muteins having higher binding affinity for human p75-TNF receptor than for human p55-TNF receptor include muteins having at least one defect amino acid relative to wild-type human TNF at a position corresponding to position 33, 65, 67, 75, 87, 143, 145 or 147 of the wild-type amino acid sequence.

Such muteins can be used to characterise human p75-receptor and, together with known muteins with selective binding affinity for human p55-TNF receptor, can aid in distinguishing between TNF functions mediated via binding to human p75-receptor and those mediated via binding to human p55-receptor.

FIG. 4

TNFR-p75



EP 0 619 372 A1

The present invention relates to Tumor Necrosis Factor Muteins.

Tumor Necrosis Factor, or more specifically Tumor Necrosis Factor-alpha (for ease of reference, unless otherwise indicated, "Tumor Necrosis Factor" or "TNF" when used herein refers to TNF- α), is a cytokine primarily produced by stimulated macrophages. It exhibits not only a striking cytotoxicity against various tumour cells [Carswell et al., *Proc. Nat. Acad. Sci., USA* 72, 3666-3670, (1975)] but also plays a multiple role as a mediator of inflammation and the immune response [for an overview see Beutler and Cerami, *Ann. Rev. Immunol.* 7, 625-655 (1989); Bonavista and Granger (eds.) "Tumor Necrosis Factor: Structure. Mechanism of Action. Role in Disease and Therapy, Karger, Basel (1990)]. The primary structure of human Tumor Necrosis Factor-alpha (hTNF- α) has been deduced from the nucleotide sequence of a cDNA which has been cloned and expressed in *E. coli* [Pennica et al., *Nature* 312, 724-729 (1984); Marmenout et al., *Europ. J. Biochem.* 152, 515-522 (1985); Wang et al., *Science* 228, 149-154 (1985); Shirai et al., *Nature* 313, 803-806 (1985)]. A striking homology in amino acid sequence (30%) was found between hTNF- α and human Lymphotoxin, often referred to as human Tumor Necrosis Factor-beta (hTNF- β), a cytokine mainly produced by activated lymphocytes [Gray et al., *Nature* 312, 721-724 (1984); Fiers et al., *Cold Spring Harbour Symp.* 51, 587-595 (1986)].

hTNF- α with modified amino acid sequences, so called TNF- α -muteins, have also been described in various publications - for example Yamagishi et al., *Protein Engineering* 3, 713-719, (1990); Fiers in "Tumor Necrosis Factors: Structure, Function and Mechanism of Action"; Fiers et al. in Bonavista and Granger, pp. 77-81 (see above); Goh et al., (1991) entitled "Structural and functional domains in human tumor necrosis factors." *Prot. Engineering* 4: 385-389; Kircheis et al., (1992) entitled "Biological activity of mutants of human tumor necrosis factor-alpha," *Immunology* 76: 433-438; Van Ostade et al., (1991) entitled "Localization of the active site of human tumor necrosis factor (hTNF) by mutational analyses," *EMBO J.* 10: 827-836; Van Ostade et al., (1993) entitled "Human TNF mutants with selective activity on the p55 receptor," *Nature* 361: 266-269; Zhang et al., (1992) entitled "Site-directed mutational analysis of human tumor necrosis factor- α receptor binding site and structure-functional relationship," *J. Biol. Chem.* 267: 24069-24075; and in Ito et al., (1991) entitled "Novel muteins of human tumor necrosis factor alpha," *Biochim. Biophys. Acta* 1096: 245-252. In addition TNF- α -muteins have been the object of several patent applications, e.g. International Patent Applications Publ. Nos. WO 86/02381, WO 86/04606, WO 88/06625 and European Patent Applications Publ. Nos. 155,549; 158,286; 168,214; 251,037 and 340,333, and Deutsche Offenlegungsschrift Nr. 3843534.

Muteins of Lymphotoxin have also been disclosed in the art, e.g. in European Patent Applications Publ. Nos. 250,000; 314,094 and 336,383, as well as in the following two publications: Goh et al., (1991) entitled "Aspartic acid 50 and tyrosine 108 are essential for receptor binding and cytotoxic activity of tumor necrosis factor beta (lymphotoxin)," *Prot. Engineering* 4: 785-791 and Wakabayashi et al., (1990) entitled "Deletion of lysine 89 enhances the cytotoxicity and the receptor binding affinity of human lymphotoxin," *J. Biol. Chem.* 265: 7604-7609.

The biological effects of TNF are mediated via specific receptors, namely a receptor with an apparent molecular weight of 55 kD on sodium dodecylsulfate polyacrylamide gel electrophoresis (SDS-PAGE) (p55-TNF-R) and a receptor with an apparent molecular weight of 75 kD on SDS-PAGE (p75-TNF-R). Both forms of TNF-receptors have been cloned, namely p55-TNF-R by Loetscher et al. [*Cell* 61, 351-359, (1990)] and p75-TNF-R for example by Dembic et al. [*Cytokine* 2, 53-58, (1990)] (for both receptors see also European Patent Application No. 90116707.2) and it was found more recently that both receptors bind not only TNF- α but also TNF- β with high affinity [Schönfeld et al., *J. Biol. Chem.* 266, 3863-3869 (1991)].

It is well known in the art that on the basis of its biological activities TNF- α can be a valuable compound for the treatment of various disorders. For example TNF- α , alone or in combination with interferon, can be an effective antitumor agent [Brouckaert et al., *Int. J. Cancer* 38, 763-769 (1986)]. However, its systemic toxicity is a major limitation to its wider therapeutic use [Taguchi T. and Sohmura Y., *Biotherapy* 3, 177-186 (1991)].

hTNF- α and mTNF- α bind with almost equal affinity to human p55-TNF-R and to human p75-TNF-R. It has, however, been shown that in mice human TNF- α (hTNF- α), only binds to the smaller mouse TNF receptor (murine p55-TNF-R). In mice hTNF- α is far less toxic than murine TNF- α (mTNF- α), which binds to both mouse receptors, mp55-TNF-R and mp75-TNF-R. For example, in C57B16 mice, the LD50 is about 10 μ g/mouse and 500 μ g/mouse with mTNF- α and hTNF- α , respectively [Brouckaert et al., *Agents and Actions* 26, 196-198 (1989); Everaerd, B. et al., *Biochem. Biophys. Res. Comm.* 163, 378-385 (1989); Lewis, M. et al., *Proc. Natl. Acad. Sci. USA* 88, 2830 (1991); Brouckaert, P., Libert, C., Everaerd, B. and Fiers, W. (1992). "Selective species specificity of tumor necrosis factor for toxicity in the mouse." *Lymphokine Cytokine Res.* 11, 193-196]. Hence it was proposed that the p75-TNF-R plays a special role in systemic toxicity.

It also has been reported that proliferative signals can be mediated by hp75-TNF-R in human T lymphocytes (Gehr et al., J. Immunol. 149, 911, 1992; Tartaglia et al., Proc. Natl. Acad. Sci. USA 88, 9292, 1991).

Human Tumor Necrosis Factor muteins, showing a significant difference between their binding affinity to the human p75-Tumor-Necrosis-Factor-Receptor (hp75-TNF-R) and to the human p55-Tumor-Necrosis-Factor-Receptor (hp55-TNF-R), have been described in European Patent Application Publication No. 486 908, where hTNF muteins are disclosed which have retained the binding activity to hp55-TNF-R, but have lost nearly all binding to hp75-TNF-R.

According to the present invention there is provided a human Tumor Necrosis Factor mutein having higher binding affinity for human p75-Tumor-Necrosis-Factor-Receptor than for human p55-Tumor-Necrosis-Factor-Receptor (the term "human Tumor Necrosis Factor Mutein" when used herein includes pharmaceutically acceptable human Tumor Necrosis Factor Mutein salts).

The amino acid sequence of (wild-type) human TNF- α as disclosed by Pennica et al. [see above] is as follows:

15

```

      1                                10
VAL ARG SER SER SER ARG THR PRO SER ASP LYS PRO VAL ALA HIS
20                                20                                30
VAL VAL ALA ASN PRO GLN ALA GLU GLY GLN LEU GLN TRP LEU ASN
                                40
ARG ARG ALA ASN ALA LEU LEU ALA ASN GLY VAL GLU LEU ARG ASP
25                                50                                60
ASN GLN LEU VAL VAL PRO SER GLU GLY LEU TYR LEU ILE TYR SER
                                70
GLN VAL LEU PHE LYS GLY GLN GLY CYS PRO SER THR HIS VAL LEU
30                                80                                90
LEU THR HIS THR ILE SER ARG ILE ALA VAL SER TYR GLN THR LYS
35                                100
VAL ASN LEU LEU SER ALA ILE LYS SER PRO CYS GLN ARG GLU THR
                                110                                120
PRO GLU GLY ALA GLU ALA LYS PRO TRP TYR GLU PRO ILE TYR LEU
40                                130
GLY GLY VAL PHE GLN LEU GLU LYS GLY ASP ARG LEU SER ALA GLU
                                140                                150
ILE ASN ARG PRO ASP TYR LEU ASP PHE ALA GLU SER GLY GLN VAL
45
50                                157
TYR PHE GLY ILE ILE ALA LEU

```

or as disclosed by Marmenout et al. (see above) or Wang et al. (see above) or Shirai et al. or more specifically as coded for by the nucleotide sequence of the insert of the plasmid pDS56/RBSII, SphI-TNF α - (SEQ ID No. 1; see Figures 1a and 1b and Example I; or Figures 3b1-3b3 of EP 486 908) coding for mature TNF- α .

Prior to the present invention there was no indication that hTNF muteins could be prepared which bind selectively to hp75TNF-R. Muteins according to the present invention can advantageously be used to characterise hp75-TNF-R and also have potential beneficial diagnostic and therapeutic applications, as will be described later.

5 Preferably the mutein comprises at least one amino acid change relative to wild-type human TNF- α at a position corresponding to position 33, 34, 65, 67, 75, 143, 145 and/or 147 of the wild-type sequence, when measured relative to the N-terminal amino acid. The term "corresponding to" is used herein to indicate that the muteins of the present invention need not be exactly homologous with wild-type human TNF- α at positions other than those indicated above, since at such positions deletions, insertions or substitutions are
10 contemplated relative to the wild-type amino-acid sequence, provided that these have no substantial effect on binding affinity to hp75-TNF-R.

Amino acid substitutions in proteins and polypeptides which do not essentially alter biological activity are known in the art and described, e.g. by H. Neurath and R.L. Hill in "The Proteins", Academic Press, New York (1979), in particular in fig. 6 of page 14. The most frequently observed amino acid substitutions
15 are Ala/Ser, Val/Ile, Asp/Glu, Thr/Ser, Ala/Gly, Ala/Thr, Ser/Asn, Ala/Val, Ser/Gly, Tyr/Phe, Ala/Pro, Lys/Arg, Asp/Asn, Leu/Ile, Leu/Val, Ala/Glu, Asp/Gly and vice versa.

Preferably the mutein comprises at least one of the following amino acid changes at a position corresponding to the position indicated for the wild-type sequence:

A33T
20 K65A
K65W
Q67K
Q67T
Q67Y
25 L75H
L75W
D143N
D143E
D143F
30 D143W
D143Y
D143V
D143V - F144L - A145S
D143N - A145R
35 D143V - A145S
A145R
A145D
A145G
A145H
40 A145K
A145F
A145S
A145T
A145W
45 A145Y
A145V
E146R
S147L

In this nomenclature the letters used represent amino acids, based upon the single letter amino acid code.
50 Dashes are used to separate amino acid changes at more than one position. For each amino acid change indicated, the first letter refers to the amino acid in wild-type human TNF- α while the second letter indicates the corresponding amino acid in the mutein. The numbers used indicate the positions in the wild-type sequence at which the amino acids indicated for the wild-type sequence occur.

Of these variants, those listed below are preferred, having been found to have particularly good binding
55 selectivity for hp75-TNF-R:

K65W
D143N
D143E

D143F

D143W

D143Y

D143V

5 D143V - F144L - A145S

D143N - A145R

D143V - A145S

A145R

A145H

10 A145K

A145F

A145W

A145Y

Particularly preferred variants are those listed below:

15 D143N

D143E

D143F

D143W

D143Y

20 D143V

D143V - F144L - A145S

D143N - A145R

D143V - A145S

A145R

25 A145K

A145F

A145W

A145Y

It is notable that all of these latter alternatives have amino acid changes at positions corresponding to positions 143 and/or 145 of the wild-type sequence. Changes at these positions are therefore preferred.

The hTNF muteins of the present invention may additionally contain sequences of several amino acids which are coded for by "linker" sequences. These sequences may arise as a result of the expression vectors used for expression of the hTNF muteins as defined above.

The hTNF muteins of the present invention can also contain specific sequences that bind with high selectivity to an affinity carrier material so as to aid purification. Examples of such sequences are sequences containing at least two adjacent histidine residues (see in this respect European Patent Application, Publication No. 282 042). Such sequences bind selectively to nitrilotriacetic acid nickel chelate resins (Hochuli and Döbeli, *Biol. Chem. Hoppe-Seyler* 368, 748 (1987); European Patent Application, Publication No. 253 303). hTNF muteins which contain such a specific sequence can be linked either to the C-terminus or the N-terminus, or to both termini, of the hTNF-mutein amino acid sequences.

The hTNF muteins of the present invention can also be combined with different immunoglobulin heavy chain or light chain polypeptides. This leads to chimeric hTNF mutein immunoglobulin polypeptides which could have increased half-life in vivo. Increased half-life in vivo has been shown, e.g., for chimeric polypeptides consisting of the first two domains of the constant regions of the heavy chain or the light chain of a mammalian immunoglobulin (see Traunecker et al., *Nature* 331, 84-86 [1988] and European Patent Application, Publication No. 394 827). Chimeric proteins of hTNF muteins fused to any other peptide sequence are also possible.

The hTNF muteins can also be coupled to polymers, e.g. polyethylene glycol or polypropylene glycol having a molecular weight of 500 to 20,000 daltons (pegylated hTNF-muteins). This leads to protected hTNF mutein compositions which could be substantially non-immunogenic. Several modes of coupling the polymer with the polypeptide are available and described, e.g., in U.S. Patent No. 4,179,337. Accordingly a pegylated hTNF-mutein or a pharmaceutically acceptable salt thereof is also an object of the present invention.

The hTNF muteins of the present invention can be produced by methods known in the art and described e.g. in Sambrook et al. [*Molecular Cloning, A Laboratory Manual*, 2nd ed., Cold Spring Harbour Laboratory, Cold Spring Harbour Laboratory Press, USA (1989)] or e.g. in the following paragraphs. Whether such hTNF muteins still show selective binding affinity for the p75-TNF-R can be determined as described in the following Examples. Alternatively, the hTNF muteins of the present invention can also be chemically

synthesized using standard methods known in the art, preferably solid state methods, such as the methods of Merrifield (J. Am. Chem. Soc. 85, 2149-2154 [1963]). Furthermore pharmaceutically acceptable salts of such muteins are also an object of the present invention. Such salts can be produced by methods known in the art.

It is believed that the strategy of dissecting beneficial and unwanted TNF- α activities by using compounds specifically binding to one or the other TNF-receptor, such as the hTNF muteins of the present invention, can be used in general in disease states where TNF plays a role.

DNA-sequences coding for hTNF-muteins as hereinbefore described are also an object of the present invention. In addition to their function as an intermediate for obtaining the muteins of the present invention, such sequences (or fragments thereof) can be used in gene therapy, whereby an existing gene can be modified to give beneficial effects. The sequences (or fragments thereof) can also be used as anti-sense DNA for the regulation of gene expression by binding to complementary mRNA sequences.

Such DNA-sequences can be constructed starting from genomic-or cDNA-sequences coding for hTNF as disclosed in the art [see above] using known methods of in vitro mutagenesis [see e.g. Sambrook et al., 1989]. RNA sequences complementary to the DNA sequences of the present invention are also within the scope of the present invention and are of utility e.g. for the preparation of cDNA sequences.

The mutagenesis referred to above can be carried out ad-random in order to obtain a large number of mutants which can then be tested for their desired properties in appropriate assay systems or, in order to mutate defined positions in a given DNA-sequence, by so called site directed mutagenesis [see e.g. Sambrook et al., 1989, 15.51-15.113] or by mutagenesis using the polymerase chain reaction [see e.g. White et al., Trends in Genetics 5, 185-189 (1989)].

One chemical mutagen which is often used for mutagenesis ad-random is sodium bisulfite which converts a cytosine residue into an uracil residue and hence leads to a transition of "C" to "T" (standard abbreviations for nucleotides) [for the method see e.g. Shortle and Nathans, Proc. Nat. Acad. Sci. U.S.A. 75, 2170-2174 (1978) or Pine and Huang, Meth. Enzym. 154, 415-430 (1987)]. This mutagen acts solely on single stranded DNA whereas the expression of the mutated target DNA sequence is achieved with a double stranded plasmid vector. One possibility to avoid the necessity of recloning in mutagenesis and expression vectors is the use of so called "phasmids". These are vectors which, in addition to a plasmid origin of replication, carry also an origin of replication derived from a filamentous phage. Examples of such phasmids are the pMa- and pMc-phasmids as described by Stanssen et al. [Nucleic Acids Res. 17, 4441-4454, (1989)]. Using this expression system one can construct so called "gap-duplex"-structures [see also Kramer et al., Nucl. Acids. Res. 12, 9441-9456 (1984)] where only the TNF-coding sequence (see above) is in a single stranded configuration and therefore accessible for the specific chemical mutagen. "gap-duplexes" to be used in ad-random mutagenesis can be constructed as described for site-specific mutagenesis by Stanssen et al. [see above] with the exception that the (-)strand contains the same active antibiotic resistance gene as the (+)strand. By making use of different restriction sites in the DNA-sequence encoding hTNF α , variation of the width of the gap is possible. Examples of such restriction sites are the C1a1-Sal1 sites (470 nucleotides), BstX1-BstX1 sites (237 nucleotides) or Sty1-Sty1 sites (68 nucleotides). Such gap-duplex-constructs can then be treated with increasing concentrations (up to 4M) of bisulfite, followed by several dialysis steps, as described by Shortle and Nathans (see above). A suitable procaryotic host cell can then be transformed by such phasmid constructs according to methods known in the art and described e.g. by Sambrook et al. (see above). A suitable procaryotic host cell means in this context a host cell deficient in a specific repair function so that an uracil residue is maintained in the DNA during replication and which host cell is capable of expressing the corresponding mutated TNF. Such specific host strains are known in the art, for example for E. coli strains, e.g. E. coli BW 313 [Kunkel, T.A., Proc. Natl. Acad. Sci. USA 82, 488-492 (1985)]. The resulting clones can then be screened for those expressing a desired hTNF mutein by appropriate assay systems. For example each colony can be inoculated in a microtiterplate in a suitable medium containing the relevant antibiotic. The cells may be lysed by addition of lysozyme, followed by sequential freeze-thaw cycles. After precipitation of nucleic acids and centrifugation, the supernatant of each colony can directly be used in appropriate assays as described, e.g., in Example III of the present specification.

If desired, the specific sites of mutation can be determined, for example by restriction fragment analysis [see e.g. Sambrook et al. (see above)]. By determination of the DNA-sequence of such fragments the exact position of the mutation can be determined and if such mutation leads to an amino acid replacement the new amino acid can be derived from the determined DNA-sequence. DNA-sequencing can be performed according to methods known in the art, e.g. by using T7 polymerase on supercoiled DNA with a commercially available sequencing kit (Pharmacia, Uppsala, Sweden).

As already mentioned above, another possibility of mutating a given DNA-sequence is by "site directed mutagenesis". A widely used strategy for such kind of mutagenesis as originally outlined by Hutchinson and Edgell [J. Virol. 8, 181 (1971)] involves the annealing of a synthetic oligonucleotide carrying the desired nucleotide substitution to a target region of a single-stranded DNA-sequence wherein the mutation should be introduced [for review see Smith, Annual. Rev. Genet. 19, 423 (1985) and for improved methods see references 2-6 in Stanssen et al. (1989)].

One such preferred method is the one of Stanssen et al. (1989) using "gapped duplex DNA" as originally described by Kramer et al. (1984) [see above and Kramer and Fritz, Methods in Enzymology, (1987), Academic Press, Inc., USA] but using antibiotic resistance genes instead of M13 functional genes for selection of the mutation containing strand in addition with the phasmid-technology as also described by Stanssen et al. (1989) [see above]. An advantage of this method lies also in the capability of performing successive cycles of mutagenesis without the need to transfer the gene to a new mutagenesis vector: second round mutagenesis differs only in the selection to another antibiotic marker (Stranssen et al., see above). As a control site-specific back mutagenesis of the mutant to the wild-type TNF can be used. In addition, the use of an oligonucleotide, creating or destroying a restriction site in the TNF gene, allows to control the mutant not only by hybridization to the oligonucleotide used for site directed mutagenesis but also by the presence or absence of the restriction site. In order to create a set of hTNF muteins wherein at a defined position of their amino acid sequence the wild-type amino acid is replaced by any naturally occurring amino acid a set of oligonucleotides is used with all possible codons at the defined position.

As already mentioned above, another possibility of mutating a given DNA-sequence is the mutagenesis by using the polymerase chain reaction (PCR). The principles of this method are outlined e.g. by White et al. (1989), whereas improved methods are described e.g. in Innis et al. [PCR Protocols: A Guide to Methods and Applications, Academic Press, Inc. (1990)].

PCR is an in vitro method for producing large amounts of a specific DNA fragment of defined length and sequence from small amounts of a template DNA. Thereby, PCR is based on the enzymatic amplification of the DNA fragment which is flanked by two oligonucleotide primers that hybridize to opposite strands of the target sequence. The primers are oriented with their 3' ends pointing towards each other. Repeated cycles of heat denaturation of the template, annealing of the primers to their complementary sequences and extension of the annealed primers with a DNA polymerase result in the amplification of the segment between the 5' ends of the PCR primers. Since the extension product of each primer can serve as a template for the other, each cycle essentially doubles the amount of the DNA fragment produced in the previous cycle. Since the primers are physically incorporated into the amplified product and mismatches between the 5' end of the primer and the template do not significantly affect the efficiency of the amplification, it is possible to alter the amplified sequence thereby introducing the desired mutation into the amplified DNA. By utilizing the thermostable Taq DNA polymerase isolated from the thermophilic bacteria *Thermus aquaticus*, it has been possible to avoid denaturation of the polymerase which necessitated the addition of enzyme after each heat denaturation step. This development has led to the automation of PCR by a variety of simple temperature-cycling devices. In addition, the specificity of the amplification reaction is increased by allowing the use of higher temperatures for primer annealing and extension. The increased specificity improves the overall yield of amplified products by minimizing the competition by non-target fragments for enzyme and primers.

Design and synthesis of oligonucleotides can be effected as known in the art and described e.g. in Sambrook et al. (1989) or in one of the references cited above with respect to site directed mutagenesis.

As soon as a DNA-sequence coding for a hTNF-mutein of the present invention has been created, expression can be effected by the phasmid technology as described above or by use of any suitable pro-or eukaryotic expression system well known in the art [see e.g. Sambrook et al., see above].

Expression is effected preferably in prokaryotic cells, e.g., in *E. coli*, *Bacillus subtilis* and so on, whereby *E. coli*, specifically *E. coli* K12 strains e.g. M15 [described as DZ 291 by Villarejo et al. in J. Bacteriol. 120, 466-474 (1974)], HB 101 [ATCC No. 33694], WK6 (Stranssens et al. see above) or *E. coli* SG13009 [Gottesman et al., J. Bacteriol. 148, 265-273 (1981)] are preferred. Expression of the hTNF muteins of the present invention can also be effected in lower or higher eukaryotic cells, like for example yeast cells (like *Saccharomyces*, *Pichia* etc.), filamentous fungi (like *Aspergillus* etc.) or cell lines (like chinese hamster ovary cell lines etc.), whereby expression in yeast cells is preferred [see Sreekrishna et al., Biochem. 28, 4117-4125, (1989); Hitzeman et al., Nature 293, 717-722 (1981); European Patent Application Publication No. 263 311]. Expression of the hTNF muteins of the present invention may occur in such systems either intracellularly, or, after suitable adaption of the gene, extracellularly (see Leemans et al., Gene 85, 99-108, 1989).

Suitable vectors used for expression in *E. coli* are mentioned e.g. by Sambrook et al. [see above] or by Fiers et al. in "Proc. 8th Int. Biotechnology Symposium" [Soc. Franc. de Microbiol., Paris, (Durand et al., eds.), pp. 680-697 (1988)] or and more specifically vectors of the pDS family [Bujard et al., Methods in Enzymology, eds. Wu and Grossmann, Academic Press, Inc. Vol. 155, 416-433 (1987); Stüber et al., Immunological Methods, eds. Lefkovits and Pernis, Academic Press, Inc., Vol. IV, 121-152 (1990)] like for example pDS56/RBSII, SphI-TNF α (D143N, A145R) (see Example I) or pDS56/RBSII, SphI-TNF α (mucin) (see Example II), where the term "mucin" represents the TNF α mucins listed in Table 1. Since with these specific pDS56/RBSII-plasmids, due to their specific regulatable promoter/operator elements and ribosomal binding sites, a high level of expression can be achieved, the plasmids can be maintained in *E. coli* cells only when the activity of the promoter/operator element is repressed by the binding of a lac repressor to the operator. The activity of the promoter can be restored at the desired cell density by addition of IPTG, which inactivates the repressor and clears the promoter. Since most of the *E. coli* strains do not provide enough repressor molecules to completely repress the function of the promoter sequences present in these high copy number plasmids, such *E. coli* strains, like *E. coli* M15 or SG13009, have to be transformed at first with a plasmid, like pREP 4 (see Figures 2a and b), coding for the lac repressor, before being transformed with the specific pDS56/RBSII-plasmids of the invention which can then be stably maintained in the *E. coli* cells. Beside coding for the lac repressor, pREP4 contains also a region of the plasmid pACYC184 [Chang and Cohen, J. Bacteriol. 134, 1141-1156 (1978)], which contains all information required for replication and stable transmission to daughter cells [for additional information see also "System for high level production in *E. coli* and rapid purification of recombinant proteins: application to epitope mapping, preparation of antibodies and structure function analysis" by Stüber et al. in Immunological Methods, Vol. IV, pp 121-152, Lefkovits and Pernis (eds.), Academic Press, New York (1990)].

Transformation of the host cells by vectors as described above may be carried out by any conventional procedure [see for example Sambrook et al. (see above)]. Where the host cell is a prokaryote, such as *E. coli* for example, competent cells which are capable of DNA uptake are prepared from cells harvested after exponential growth phase and subsequently treated according to the known CaCl₂-method. Transformation can also be performed after forming a protoplast of the host cell or by other methods known in the art and described, e.g., in Sambrook et al. (see above). Therefore a vector, especially for expression in a prokaryotic or lower eukaryotic host cell, comprising a DNA-sequence coding for an hTNF mucin as described above, and a host cell, especially a prokaryotic host cell, e.g. *E. coli*, or a lower eukaryotic host cell, transformed by such a vector are also an object of the present invention.

Usually, the host organisms which contain a desired expression vector are grown under conditions which are optimal for their growth. In case of a prokaryotic host at the end of the exponential growth, when the increase in cell number per unit time decreases, the expression of the desired hTNF mucin is induced, i.e. the DNA coding for the desired hTNF mucin is transcribed and the transcribed mRNA is translated. The induction can be carried out by adding an inducer or a derepressor to the growth medium or by altering a physical parameter, e.g. a change in temperature. In the expression vectors used in the preferred embodiments of the present invention, the expression is controlled by the lac repressor. By adding isopropyl- β -D-thiogalactopyranoside (IPTG), the expression control sequence is derepressed and the synthesis of the desired hTNF mucin is thereby induced.

The hTNF mucins of the present invention produced by transformed host cells as stated above can be recovered from the culture medium or after opening the cells and/or extraction by any appropriate method known in protein and peptide chemistry such as, for example, precipitation with ammonium sulfate, dialysis, ultrafiltration, gel filtration or ion-exchange chromatography, gel electrophoresis, isoelectric focusing, affinity chromatography, like immunoaffinity chromatography, HPLC or the like. Specifically preferred methods are precipitation with ammonium sulfate and/or polyethylenimine, dialysis, affinity chromatography, e.g. on phenyl-agarose, specifically phenyl-sepharose, or ion-exchange chromatography, specifically on a MONO-Q- and/or MONO-S-matrix (Pharmacia, Uppsala, Sweden) or more specifically are those as described by Tavernier et al. [J. Mol. Biol. 211, 493-501 (1990)] and those disclosed in Example IV.

It is therefore also an object of the present invention to provide a process for the preparation of hTNF mucins as specified above which process comprises cultivating a transformed host cell as described above, especially a prokaryotic, e.g. *E. coli* or eukaryotic host cell in a suitable medium and isolating a mucin from the culture supernatant or the host cell itself, and if desired pegylating said mucin or preparing a pharmaceutically acceptable salt thereof by methods known in the art. The compounds whenever prepared according to such a process are also an object of the present invention.

The hTNF mucins of the present invention are characterized by showing a selective binding affinity for the human p75-TNF-R. Such property can be determined by any assay known in the art measuring binding affinities. For example the binding of TNF itself and of the mucins of the present invention can be

measured using cells in cell culture which express the two types of TNF-receptors to a different degree, like for example Hep-2 cells which exclusively express the human p55-TNF-R and U937 or HL60 cells which express in addition also the human p75-TNF-R [see Brockhaus et al., *Procd. Nat. Acad. Sci. U.S.A.* 87, 3127-3131, (1990); Hohmann et al., *J. Biol. Chem.* 264, 14927-14934, (1989); Loetscher et al. (1990); Dembic et al. (1990)]. Of course binding affinities can also be determined directly by using purified native or recombinant p55-TNF-R and p75-TNF-R as specifically described in the Examples, or by using the corresponding soluble analogs of such receptors.

The term selective binding affinity for the human p75-Tumor-Necrosis-Factor-Receptor" refers in the context of the present invention to a difference in binding affinities to the two types of TNF-receptor. Preferably, with respect to the assay system described in the examples, a mutein of the present invention binds selectively to hp75-TNF-R (desirably to a degree similar to wild-type TNF) but has essentially lost binding to hp55-TNF-R. Desirably, in the context of the assay-system of the Examples, the K_D -value of a specific hTNF mutein of the present invention is at least a factor of 10 or more, more desirably at least a factor of 10^2 , larger than for wild-type TNF- α determined by using the in vitro binding assay with recombinant soluble hp55-TNF-R, whereas its K_D -value determined by using the in vitro binding assay in respect of recombinant soluble hp75-TNF-R for the same hTNF mutein desirably differs not by more than a factor of 20 from that of wild-type TNF- α . It should be understood, however, that these specific K_D -values are given for illustration and should not be considered as limiting in any manner.

The hTNF muteins may be administered alone or with one or more additional compounds of the present invention in pharmaceutically acceptable oral, injectable or topical compositions and modes. Administration will be in a dosage such that the amount of the composition in the patient is effective to modify the biological function associated with hTNF mutein function.

Pharmaceutical compositions containing hTNF muteins in association with a compatible pharmaceutically acceptable carrier material are therefore a further object of the present invention. Any conventional carrier material can be utilized. The carrier material can be an organic or inorganic one suitable for enteral, percutaneous or parenteral administration. Suitable carriers include water, gelatin, gum arabic, lactose, starch, magnesium stearate, talc, vegetable oils, polyalkylene-glycols, petroleum jelly and the like. Furthermore, the pharmaceutical preparations may contain other pharmaceutically active agents. Additional additives such as flavouring agents, preservatives, stabilizers, emulsifying agents, buffers and the like may be added in accordance with accepted practices of pharmaceutical compounding.

The pharmaceutical preparations can be made up in any conventional form including: a) a solid form of oral administration such as tablets, capsules, pills, powders, granules and the like; b) a liquid form for oral administration such as solutions, syrups, suspensions, elixirs and the like; c) preparations for parenteral administration such as sterile solutions, suspensions or emulsions; and d) preparations for topical administrations such as solutions, suspensions, ointments, creams, gels, micronized powders, aerosols and the like. The pharmaceutical preparations may be sterilized and/or may contain adjuvants such as preservatives, stabilizers, wetting agents, emulsifiers, salts for varying the osmotic pressure and/or buffers.

Parenteral dosage forms may be infusions or injectable solutions which can be injected intravenously or intramuscularly. These preparations can also contain other medicinally active substances. Additional additives such as preservatives, stabilizers, emulsifying agents, buffers and the like may be added in accordance with accepted practices of pharmaceutical compounding.

Accordingly it is also an object of the present invention to provide a process for the preparation of a pharmaceutical composition which process is characterized in that a compound obtained by a process of the present invention and if desired, additional pharmaceutically active substances are mixed with a non-toxic, inert, therapeutically compatible carrier material and the mixture is brought into a galenical application form.

Furthermore the use of a compound prepared according to a process of the present invention for the preparation of a pharmaceutical composition as described above is also an object of the present invention.

Finally, antibodies can be raised against the hTNF muteins of the present invention. These antibodies can be used in a well-known manner for diagnostic or therapeutic purposes as well as for purification purposes. Such antibodies can be produced by injecting a mammalian or avian animal with a sufficient amount of a vaccine formulation comprising a hTNF mutein of the present invention and a compatible pharmaceutical carrier to elicit the production of antibodies against said hTNF mutein. The appropriate amount of the hTNF mutein which would be required would be known to one of skill in the art or could be determined by routine experimentation. As used in connection with this invention, the term "pharmaceutical carrier" can mean either the standard compositions which are suitable for human administration or the typical adjuvants employed in animal vaccinations.

As pointed out above, TNF is a potent pleiotropic cytokine. Its many different activities such as, for example, the activity of growth factor for immune cells, mediator in inflammation, or inducer of specific genes in endothelium, may be seen in the context of host defense to infection and injury. TNF also exhibits high systemic toxicity; the deleterious effects of bacteraemia and septic shock or of bacterial meningitis are mediated to a large extent by endogenous cytokines among which TNF has an early and important role. Furthermore, many cells and cell lines are sensitive to a direct cytotoxic activity of TNF. Various systemic effects and cellular toxicity presumably combine in the antitumor activity of TNF seen in animal studies.

These facts form the rational basis for the development of novel therapeutic strategies using the hTNF muteins of the present invention, where in particular the potential to dissect the many different hTNF activities shall be fully exploited to separate unwanted from desired activities by selectively activating only one of the two hTNF receptor types (in contrast to wild-type hTNF which binds and activates both). The potential use of the hTNF muteins of the present invention is not restricted to cancer therapy. Any disease where TNF as host defense factor in bacterial infection [for example Kindler, V. et al., CELL 56, 731-740 (1989); Nakano, Y. et al., J. Immunol. 144, 1935, (1990)] or as mediator in inflammation plays a beneficial role might benefit from a 75kDa TNF receptor type specific drug such as the hTNF muteins of the present invention. Furthermore, TNF α has been shown to have certain catabolic effects on fat cells and on whole animals, and to play a role in cachexia [eg. Beutler, B. and Cerami, (see above); Hotamisligil et al., Science 259, 87 1993] and TNF muteins of the present invention might be used in treating obesity. It also has been shown that TNF α has a neutralising effect on the insulin-stimulated peripheral glucose utilisation rate [Hotamisligil et al., see above]. Such a putative role of TNF α in obesity-linked insulin resistance might be reconciled with its possible role in cachexia by dose-dependent differences in biological effects and distinct roles of the two TNF receptor systems which might be exploited by receptor-type specific agonists in the presence or absence of wild-type TNF-inhibitors. Even disease states characterised by the toxic activities exerted by excessive TNF release such as septic shock or bacterial meningitis might benefit from TNF receptor specific agonists such as the muteins of the present invention above, alone, or in combination with wild-type TNF antagonists.

A concise summary of the emerging role of TNF for novel therapies, where TNF-Receptor type specific agonists selectively triggering only some of the many different TNF activities may be expected to have significant advantages when compared to wild-type TNF, has been published [Tumor Necrosis Factors, The Molecules and their Emerging Role in Medicine, B. Beutler, ed., Raven Press, 1992, ISBN 0-88167-852-X]. It includes the activities of TNF in modulating endothelial cell homeostatic properties and neutrophil adhesion, tissue ischemia and reperfusion injury, on osteoblasts and osteoclasts in bone resorption, as growth factor on many cells in general and in hematopoiesis, as well as in metabolic and nutritional effects. TNF as a growth/differentiation factor in the generation of lymphokine-activated killer (LAK) cells appears to contribute to the antitumor activities of TNF. Accordingly the use of the hTNF-muteins of the present invention or of pharmaceutically acceptable salts thereof is also an object of the present invention.

All these activities may be enhanced or modulated in combination with other recombinant cytokines such as, for example, interferon gamma.

The present invention will now be described, by way of example only, with respect to the accompanying drawing,

Abbreviations and symbols used are:

B, E, H, S, Xb and X which indicate cleavage sites for restriction enzymes BglI, EcoRI, HindIII, Sall, XbaI and XhoI, respectively.



represents the regulatable promoter/operator element N25OPSN25OP29,



represents the synthetic ribosomal binding site RBSII, SphI,



represents genes for TNF α (TNF α), β -lactamase (bla), chloramphenicol acetyltransferase (cat), lac repressor (lacI) and neomycin phosphotransferase (neo).



represents transcriptional terminators t_0 of phage lambda (t_0) and T1 of the E. coli rrnB operon (T1)

represents the replication regions of plasmids pBR322 and pREP4 (repl.).

represents the coding region under control of N250PSN250P29 and RBSII, SphI.

Figure 1a is a schematic drawing of the plasmid pDS56/RBSII, SphI-TNF α .

Figure 1b displays the complete nucleotide sequence of plasmid pDS56/RBSII, SphI-TNF α (SEQ ID No. 1). In this sequence, the recognition sequences of the restriction enzymes depicted in Figure 1a are indicated. The amino acid sequence shown represents in the three letter code the sequence of the mature human TNF α (157 amino acids; SEQ ID No. 1 and 2).

Figure 2a is a schematic drawing of the plasmid pREP4.

Figure 2b displays the complete nucleotide sequence of plasmid pREP4 (SEQ ID No. 3). In this sequence, the recognition sequences of the restriction enzymes depicted in Figure 2a are indicated (see also Figures 2b1-2b3 of EP 486 908).

Figure 3 outlines the preparation of an EcoRI-HindIII fragment encoding the TNF α mutein TNF α - (D143N, A145R).

Figure 4 illustrates the Competitive binding of Human Wild-type TNF α and D143N, A145R and D143N-A145R Muteins to Human TNFR-p75 and TNFR-p55. 96 well microtiter plates coated with recombinant human TNFR-p75-h γ 3 fusion protein (upper panel) and recombinant human TNFR-p55-h γ 3 fusion protein (lower panel) were incubated with radiolabelled human TNF α in the presence of different concentrations of unlabelled wild-type TNF α , D143N, A145R or D143N-A145R muteins. After three hours at room temperature bound radioactivity was counted in a γ -counter.

Unless otherwise specified, percentages given below for solids in solid mixtures, liquids in liquids and solids in liquids are on a wt/wt, vol/vol and wt/vol basis, respectively.

Example I

Preparation of TNF α (D143N-A145R)

Plasmid pDS56/RBSII, SphI-TNF α

The human TNF α expression plasmid pDS56/RBSII, SphI-TNF α (see Figure 1) was the source of the TNF α gene for preparation of the various TNF α muteins of this invention. The transformed E. coli strain M15 [pREP4; pDS56/RBSII, SphI-TNF α] has been deposited under the Budapest Treaty for patent purposes at the Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH (DSMZ) in Braunschweig, BRD, at September 8, 1991, under the accession number DSM 6713.

Mutagenesis of the TNF α gene using PCR

Two PCR reactions were performed with plasmid pDS56/RBSII, SphI-TNF α (Figure 1) as the template DNA using a Perkin-Elmer Cetus GeneAmpTM DNA Amplification Reagent Kit with AmpliTaqTM Recombinant Taq DNA Polymerase [see Figure 3].

Reaction I was performed with primers 17/F [5'-GGCGTATCACGAGGCCCTTTTCG-3' (SEQ ID No. 4); primer 17/F comprises nucleotides 3949-3970 of plasmid pDS56/RBSII, SphI-TNF α] and 46/M12 [5'-GCGAAAGTIGAGATAGTCGGGCCGATTG-3' (SEQ ID No. 5); primer 46/M12 comprises nucleotides which

are complementary to nucleotides 552-525 of plasmid pDS56/RBSII,SphI-TNF α , the mutated bases are underlined].

Reaction II was performed with primers 29/MR2 [5'-GAGTCTGGGCAGGTCTACTTTG-3' (SEQ ID No. 6); primer 29/MR1 comprises nucleotides 553-574 of plasmid pDS56/RBSII,SphI-TNF α] and 17:O [5'-CATTAC TGGATCTATCAACAGG-3' (SEQ ID NO. 7); primer 17:O comprises nucleotides which are complementary to nucleotides 748-727 of plasmid pDS56/RBSII,SphI-TNF α].

In a typical experiment, 10 μ l template DNA (10 ng), 5 μ l each of the two primers (100 pmoles each), 16 μ l dNTP's mix (1.25 mM of dATP, dGTP, dCTP, and dTTP), 10 μ l 10x reaction buffer (100 mM Tris-HCl pH8.3, 500 mM KCL, 15 mM MgCl₂ and 0.1 % gelatin), 1 μ l (5 units) AmpliTaq™ DNA polymerase and 53 μ l H₂O were mixed in an Eppendorf tube and overlaid with 80 ml mineral oil (Perkin-Elmer Cetus). The tubes were transferred to a DNA thermal cycler (TRIO-Thermoblock, Biometra) and kept for 1 min at 94°C, before 35 cycles of melting the DNA (1 min at 94°C), annealing the primers (1 min at 50°C), and extending the primers (3 min at 72°C) were performed. After additional 2 min at 72°C, the reactions were cooled to room temperature and extracted with chloroform. The DNA present in the aqueous phase was precipitated with ethanol and subjected to electrophoresis in a 6 % polyacrylamide gel [Sambrook et al., 1989]. After staining of the DNA with ethidium bromide, fragments I and II (see Figure 3) were isolated from the gel and purified [Sambrook et al., 1989].

Preparation of a DNA fragment encoding TNF α (D143N-A145R)

Fragments I and II were enzymatically phosphorylated, before they were ligated with each other [Sambrook et al., 1989]. After heat-inactivation of the ligase and digestion with restriction enzymes EcoRI and HindIII, the DNA was subjected to electrophoresis in a 6 % polyacrylamide gel. After staining of the DNA with ethidium bromide, the EcoRI-HindIII fragment A [see Figure 3] was isolated from the gel and purified [see above].

Preparation of a plasmid encoding TNF α (D143N-A145R)

The EcoRI-HindIII fragment A was inserted according to standard methods [Sambrook et al., 1989] into the EcoRI-HindIII opened plasmid pDS56/RBSII,SphI-TNF α generating the plasmid pDS56/RBSII,SphI-TNF α (D143N-A145R). Plasmid DNA was prepared [Birnboim et al., 1979] and the identity of the coding region for the TNF α mutein was confirmed by sequencing the double-stranded DNA [Sambrook et al., 1989].

Production of TNF α (D143N-A145R)

Plasmid pDS56/RBSII,SphI-TNF α (D143A-A145R) was transformed into E. coli M15 cells containing already plasmid pREP4 by standard methods [see above]. Transformed cells were grown at 37°C in LB medium [Sambrook et al., 1989] containing 100 mg/l ampicillin and 25 mg/l kanamycin. At an optical density at 600 nm of about 0.7 to 1.0 IPTG was added to a final concentration of 2 mM. After additional 2.5 to 5 h at 37°C the cells were harvested by centrifugation.

Example II

Preparation of additional TNF α muteins

The additional TNF α muteins listed in Table I were prepared following the procedure described in detail in Example I for the preparation of TNF α (D143N-A145R). The resulting expression plasmids, which are analogous to plasmid pDS56/RBSII,SphI-TNF α (D143N-A145R), were given the name pDS56/RBSII,SphI-TNF α (mutein), where the term 'mutein' represents the TNF α muteins listed in Table 1. These plasmids contain coding regions for the TNF α muteins, in which codons present in plasmid pDS56/RBSII,SphI-TNF α are replaced by codons encoding the said muteins (see Table 1).

Example III

Analysis of Receptor Type-Specific Binding Activity of Human

TNF α Muteins in E. coli Lysates

Preparation of E. coli Lysates

10 ml suspensions of E. coli cells transformed and induced as described in Examples I and II were centrifuged at 4'000 rpm for 10 min and resuspended in 0.9 ml of lysis buffer (10 mM Tris-HCl pH 8.0, 5 mM EDTA, 2 mM PMSF, 10 mM benzamidine, 200 units/ml aprotinine and 0.1 mg/ml lysozyme). After 20 min incubation at room temperature 50 μ l of 1 M $MgCl_2$, 20 μ l of 5 mg/ml DNaseI, 50 μ l of 5 M NaCl and 50 μ l of 10% NP-40 were added and the mixture was further incubated at room temperature for 15 min. 0.5 ml of the lysate clarified by centrifugation at 13'000 rpm for 5 min was subjected to ammonium sulfate precipitation (25% - 70% cut). The 70% ammonium sulfate pellet was dissolved in 0.2 ml PBS and analyzed by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) to confirm presence and approximate amount of the recombinant proteins.

Solid Phase Radioligand Competition Binding Assay

96 well microtiter plates were coated with recombinant human TNFR-p75-h γ 3 and TNFR-p55-h γ 3 fusion proteins (extracellular portion of the receptor fused to the Fc part of human IgG3) at a concentration of 0.3 μ g/ml and 0.1 μ g/ml, respectively, in phosphate buffered saline (PBS, 100 μ l/well, overnight at 4°C) [Loetscher, H. et al. J. Biol. Chem. 266, 18324 - 18329 (1991); Lesslauer, W. et al. Eur. J. Immunol. 21, 2883 - 2886 (1991)]. After blocking with blocking buffer (50 mM Tris pH 7.4, 140 mM NaCl, 5 mM EDTA, 0.02% NaN_3 , 1% defatted milk powder) the microtiter plate was washed with PBS and incubated in blocking buffer containing 0.1% defatted milk powder with 10 ng/ml human wild-type ^{125}I -TNF α and various dilutions of E. coli lysates ranging from 10^{-2} to 10^{-7} (10-fold serial dilutions). TNF α was labelled by the lodogen method (Pierce Chemical Company) to a specific activity of about 10-30 μ Ci/ μ g. The volume was 100 μ l/well and each lysate dilution was assayed in duplicate or triplicate. After three hours at room temperature the wells were thoroughly washed with PBS and counted in a γ -counter. The results are given in Table 2 for lysates comprising the muteins indicated therein.

Example IVPurification of Human TNF α Muteins

One liter overnight cultures of E. coli cells transformed and induced as described in the Examples I and II were collected by centrifugation and resuspended in 20 ml 50 mM Tris pH 7.2, 200 mM KCl, 50 mM $MgCl_2$, 5% glycerol. The cells were disrupted in a French press at a pressure of 20'000 psi or by sonication in a Branson Sonifier (Model 450, 2 x 2min at maximal output, on ice). After clarification by centrifugation (70'000 x g, 30 min, 4°C) the samples were dialyzed against 20 mM Tris-HCl pH 9.0 overnight at 4°C and applied to a Q-Sepharose column (Pharmacia, 2.6 x 15 cm) equilibrated in the same buffer. Proteins were eluted with a linear NaCl gradient (0 to 400 mM in 20 mM Tris pH 9.0) at a flow rate of 1 ml/min. 5 ml fractions were collected and analyzed for the presence of TNF α muteins by SDS-PAGE. Positive fractions were pooled, dialyzed against 20 mM 2-morpholino-ethanesulfonic acid (MES) pH 6.0 and applied to a MonoS column (HR 5/5, LKB-Pharmacia) equilibrated in 20 mM MES pH 6.0. Proteins were eluted with a linear NaCl gradient (0 to 400 mM in 20 mM MES pH 6.0) at a flow rate of 0.5 ml/min. The various TNF α muteins eluted as electrophoretically pure proteins between 250 mM and 350 mM NaCl. After dialysis against PBS the protein concentration was determined by the BCA Protein Assay (Pierce Chemical Company) using wild-type human TNF α as a standard or by absorbance measurements at 280 nm.

Example VCompetitive Binding of Purified Human Wild-type TNF α and Muteins to Recombinant Human TNFR-p75 and TNFR-p55

For the competitive binding assay using purified muteins microtiter plates were coated with recombinant human TNFR-p75-h γ 3 and TNFR-p55-h γ 3 fusion proteins as described in Example III. After blocking with blocking buffer (50 mM Tris pH 7.4, 140 mM NaCl, 5 mM EDTA, 0.02% NaN_3 , 1% defatted milk powder) the microtiter plate was washed with PBS and incubated in blocking buffer containing 0.1% defatted milk powder with 10 ng/ml human wild-type ^{125}I -TNF α and various concentrations of unlabelled wild-type TNF α or muteins ranging from 10^2 to 10^{-5} μ g/ml (10-fold serial dilutions). TNF α was labelled by the lodogen method (Pierce Chemical Company) to a specific activity of about 10-30 μ Ci/ μ g. The volume was 100

μ l/well and each concentration was assayed in duplicate or triplicate. After three hours at room temperature the wells were thoroughly washed with PBS and counted in a γ -counter.
The results are given in Table 3 and illustrated in Fig. 4 for the muteins indicated therein.

Table 1**Codons used to encode the new amino acids present in the muteins**

Mutein	New Codon
N19D	GAC
Q21S	TCT
L29S ^a	TCC
L29S-R32W	TCC-TGG
L29S-R32W-S86T	TCC-TGG-ACC
L29S-S86T	TCC-ACC
N30T	ACC
R31E	GAG
R31K	AAG
R31N-R32T	AAC-ACT
R31N-R32T-N34S	AAC-ACT-AGT
R31N-R32T-S86T	AAC-ACT-ACC
R31E-S86T	GAG-ACC
R32W ^a	TGG
R32W-S86T	TGG-ACC
A33D	GAC

	A33T	ACC
	N34R	CGT
5	N34D	GAC
	N34C	TGT
10	N34Q	CAA
	N34E	GAA
	N34G	GGT
15	N34H	CAC
	N34I	ATT
	N34M	ATG
20	N34F	TTT
	N34P	CCT
25	N34T	ACT
	N34Y	TAT
	N34Y	TAC
30	N34V	GTT
35	K65A	GCA
	K65W	TGG
	Q67K	AAA
40	Q67T	ACA
	Q67Y	TAC
	H73Q	CAA
45	H73T	ACT
	L75R	CGT
50	L75H	CAC
55		

	L75W	TGG
5	S86D	GAC
	S86T	ACC
10	Y87Q	CAG
	Y87Q-Q88Δ	CAG-
15	Y87E	GAA
	Y87G	GGT
	Y87L	CTG
20	Y87K	AAA
	Y87F	TTC
25	Y87T	ACC
	Y87T-E104G	ACC-GGG
30	N92R	CGT
	I97K	AAG
35	I97Y	TAC
	S99A	GCA
	S99Y	TAC
40	Y115W	TGG
45	D143N	AAC
	D143E	GAA
	D143F	TTC
50	D143W	TGG

55

	D143Y	TAC
	D143V	GTC
5	D143V-F144L-A145S	GTC-CTG-TCC
	D143N-A145R	AAC-CGC
10	D143V-A145S	GTC-TCC
	F144R	CGT
	F144D	GAT
15	F144G	GGT
	F144L	TTG
	F144W	TGG
20	F144Y	TAC
	A145R	CGC
25	A145D	GAT
	A145G	GGT
	A145H	CAC
30	A145K	AAA
	A145F	TTT
	A145S	TCC
35	A145T	ACA
	A145W	TGG
40	A145Y	TAC
	A145V	GTT
	E146R	CGT
45	S147N	AAC
	S147L	CTG

50

55

a the L29S and R32W muteins have been constructed in
the laboratory of Dr. W. Fiers, University of Ghent (see also EP
486 908).

Table 2**Binding of human TNF α Muteins to TNFR-p55 and TNFR-p75**

Mutein	Dilution of E. coli Lysate for 50% Inhibition of ^{125}I -TNF α Binding, ID50 <i>a)</i>		<u>ID50 TNFR-p55</u> <i>b)</i> ID50 TNFR-p75
	TNFR-p55	TNFR-p75	
	- fold	- fold	
wildtype <i>c)</i>	14'260	14'140	1
N19D	5'000	5'000	1
Q21S	2'500	2'500	1
L29S <i>c) e)</i>	2'980	<100	>29.8
L29S-R32W	5'000	<<100	>>50
L29S-R32W-S86T	2'500	<<100	>>25
L29S-S86T	200	<<100	>>2
N30T	2'860	2'500	1.1

	R31E <i>c)</i>	3'470	180	19.3
5	R31K	3'330	3'330	1
	R31N-R32T <i>c)</i>	3'260	<100	>32.6
10	R31N-R32T-N34S	<<100	<<100	1
	R31N-R32T-S86T	500	<100	>5
15	R31E-S86T	2'000	<<100	>>20
	R32W <i>c) e)</i>	8'780	<100	>87.8
20	R32W-S86T	3'330	<<100	>>33.3
	A33D	<100	<<100	>1
25	A33T	1'110	1'250	0.9
	N34R <i>d)</i>	<100	<<100	>1
30	N34D	250	<100	>2.5
	N34C	250	<100	>2.5
35	N34Q	<100	<<100	>1
	N34E	330	<<100	>>3.3
40	N34G	330	<100	>3.3
	N34H	670	<100	>6.7
45	N34I <i>d)</i>	200	<100	>2
	N34M <i>d)</i>	<100	<<100	>1
50	N34F <i>d)</i>	100	<100	>1
	N34P	<100	<<100	>1

55

	N34T	1'000	<100	>10
5	N34Y <i>d)</i>	<100	<<100	>1
	N34Y <i>d)</i>	<100	<<100	>1
10	N34V <i>d)</i>	<100	<<100	>1
15	K65A	20'000	33'330	0.6
	K65W <i>d)</i>	500	3'330	0.2
20	Q67K	25'000	50'000	0.5
	Q67T	25'000	33'330	0.75
25	Q67Y	20'000	33'330	0.6
	H73Q	10'000	10'000	1
30	H73T	2'000	2'000	1
	L75R	<100	<100	1
	L75H	1'670	2'500	0.7
35	L75W	220	330	0.7
40	S86D	6'670	1'000	6.7
	S86T	10'000	<100	>100
45	Y87Q	<<100	<<100	1
	Y87Q-Q88Δ	<<100	<<100	1
50	Y87E	<100	<<100	>1

	Y87G	<<100	<<100	1
5	Y87L	<<100	<<100	1
	Y87K	<<100	<<100	1
10	Y87F	200	<100	>2
	Y87T	<<100	<<100	1
15	Y87T-E104G	<100	<100	1
20	N92R	5'000	1'250	4
	I97K	143	<100	>1.4
25	I97Y	2'500	330	7.6
	S99A	6'670	6'670	1
30	S99Y	<100	<100	1
	Y115W	2'220	2'220	1
35	D143N c)	<<100	330	<<0.3
	D143E	<100	330	<0.3
40	D143F	<<100	250	<<0.4
	D143W	<<100	100	<<1
45	D143Y c)	<<100	1'330	<<0.08
	D143V	<<100	<100	<1
50	D143V-F144L-A145S	<<100	<100	<1

55

	D143N-A145R <i>d)</i>	<<100	125	<<0.8
5	D143V-A145S <i>c)</i>	<<100	200	<<0.5
	F144R	2'500	330	7.6
10	F144D	5'000	330	15.2
	F144G	2'500	2'000	1.2
15	F144L	5'000	5'000	1
	F144W	400	180	2.2
20	F144Y	2'860	2'860	1
	A145R	<100	3'330	<0.03
25	A145D	5'000	6'670	0.7
	A145G	2'500	6'670	0.4
30	A145H	330	1'670	0.2
	A145K	<100	1'820	<0.05
35	A145F <i>c)</i>	240	6'000	0.04
	A145S	14'290	25'000	0.6
40	A145T	5'000	6'670	0.7
	A145W <i>d)</i>	<<100	<100	<1
45	A145Y	1'670	11'110	0.1
	A145V	1'000	2'000	0.5
50	E146R	6'670	<100	>67
	S147N	10'000	10'000	1

S147L

2'000

3'330

0.6

5

Human wildtype TNF α and muteins were expressed in *E. coli* and extracted by lysis of the bacteria. Selective receptor binding activity of extracted wildtype and mutant TNF α was measured in a solid phase radioligand binding assay. Different dilutions of the *E. coli* lysates ranging from 10^{-2} to 10^{-7} (10-fold serial dilutions) were tested for competitive binding inhibition of human wildtype ^{125}I -TNF α to immobilized human TNFR-p75 and TNFR-p55. ID₅₀'s (dilution for 50% inhibition) were determined by plotting binding inhibition versus dilution of the lysate. Since the concentration of the recombinant proteins in the lysates varied between 0.05 and 1 mg/ml as estimated from SDS-PAGE analysis, the absolute ID₅₀ values should not be considered as relevant. Receptor selectivity is indicated by directly comparing the ID₅₀ values of a particular mutein for TNFR-p75 and TNFR-p55.

30

a) "<" indicates a value less than that of the figure given (here there was measurable inhibition of ^{125}I -TNF α binding but without reaching 50% inhibition at the lowest dilution tested of 1:100).

35

"<<" indicates a value considerably less than that of the figure given (here there was no measurable inhibition at the lowest dilution tested of 1:100).

40

b) ratio = 1, no receptor selectivity;

45

ratio > 1, TNFR-p55 selectivity;

ratio < 1, TNFR-p75 selectivity;

50

55

Muteins of the present invention should have an

ID50 TNFR-p55

ID50 TNFR-p75

value of less than 1. This can be less than 0.5, but is preferably less than or equal to 0.2 (see the muteins of claim 5) and more preferably is less than or equal to 0.1 (see the muteins of claim 6). Where the symbols "<" or "<<" are used in Table 1, the muteins concerned shall, optionally, be considered to be within these ranges.

c) for these muteins at least three different lysates have been prepared and assayed; the average ID50's are listed.

d) these muteins were only partially soluble under the conditions used to prepare the E. coli lysate (although it should be noted that different purification methods could be used resulting in different solubilities); the concentration of soluble mutein in these lysates was estimated by SDS-PAGE analysis to be less than 0.05 mg/ml.

e) the L29S and R32W muteins have been constructed in the laboratory of Dr. W. Fiers, University of Ghent (see also EP 486 908).

Table 3

**Binding of Selected Human TNF α Muteins to Human
TNFR-p75 and TNFR-p55**

Mutein	Mutein Concentration for 50% Inhibition of ^{125}I -TNF α Binding, IC $_{50}$ <i>a)</i>		Decrease in Binding Affinity with Respect to Wildtype <i>b)</i>	
	TNFR-p55	TNFR-p75	TNFR-p55	TNFR-p75
	<i>ng/ml</i>	<i>ng/ml</i>	<i>-fold</i>	<i>-fold</i>
D143N	>100'000	300	>2'500	6.7
D143Y	>100'000	350	>6'660	17.5
A145F	500	30	33	1.5
A145R	100'000	35	2'500	0.8
A145W	10'000	100	250	2.5
D143N- A145R	>>100'000	300	>>2'500	6.7

Muteins with preferential binding to human TNFR-p75 were selected (see Table 2) and purified to apparent homogeneity by sequential ion exchange

chromatography. Selective receptor binding activity of the purified muteins was measured in a solid phase radioligand binding assay.

Different mutein concentrations ranging from 10^2 to 10^{-5} $\mu\text{g/ml}$ (10-fold serial dilutions) were tested for competitive binding inhibition of human wildtype ^{125}I -TNF α (10 ng/ml) to immobilized human TNFR-p75 and TNFR-p55. IC₅₀'s (concentration for 50% inhibition) were determined by plotting binding inhibition versus concentration (illustrated in Figure 1).

a) >, indicates measurable binding competition but without reaching 50% at 100 $\mu\text{g/ml}$;

>>, indicates no measurable binding competition at the highest concentration tested (100 $\mu\text{g/ml}$).

b) The decrease in affinity has been calculated by dividing the IC₅₀ values obtained for the muteins by the IC₅₀ values obtained for wildtype TNF α . The IC₅₀ value for wildtype TNF α has been determined in each individual set of experiments and was found to vary between 15 to 45 ng/ml depending on the lot of radioiodinated TNF α .

SEQUENCE LISTING

(1) GENERAL INFORMATION:

(i) APPLICANT:

(A) NAME: F. HOFFMANN-LA ROCHE AG
(B) STREET: Grenzacherstrasse 124
(C) CITY: Basle
(D) STATE: BS
(E) COUNTRY: Switzerland
(F) POSTAL CODE (ZIP): CH-4002
(G) TELEPHONE: 061 - 688 25 05
(H) TELEFAX: 061 - 688 13 95
(I) TELEX: 962292/965542 hlr ch

(ii) TITLE OF INVENTION: Tumor Necrosis Factor Muteins

(iii) NUMBER OF SEQUENCES: 7

(iv) COMPUTER READABLE FORM:

(A) MEDIUM TYPE: Floppy disk
(B) COMPUTER: IBM PC compatible
(C) OPERATING SYSTEM: PC-DOS/MS-DOS
(D) SOFTWARE: PatentIn Release #1.0, Version #1.25 (EPO)

(vi) PRIOR APPLICATION DATA:

(A) APPLICATION NUMBER: EP 93810224.1
(B) FILING DATE: 29-MAR-1993

(2) INFORMATION FOR SEQ ID NO: 1:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 3977 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: circular

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iii) ANTI-SENSE: NO

(v) FRAGMENT TYPE: internal

(vi) ORIGINAL SOURCE:

(A) ORGANISM: Plasmid pDS56/RBSII, SphI-TNFalpha

(ix) FEATURE:

(A) NAME/KEY: CDS
(B) LOCATION: 118..591

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 1:

CTCGAGAAAT CATAAAAAAT TTATTTGCTT TGTGAGCGGA TAACAATTAT AATAGATTCA 60
ATTGTGAGCG GATAACAATT TCACACAGAA TTCATTAAAG AGGAGAAATT AAGCATG 117

	GTC AGA TCA TCT TCT CGA ACC CCG AGT GAC AAG CCT GTA GCC CAT GTT	165
	Val Arg Ser Ser Ser Arg Thr Pro Ser Asp Lys Pro Val Ala His Val	
	1 5 10 15	
5	GTC GCG AAC CCT CAA GCT GAG GGG CAG CTC CAG TGG CTG AAC CGC CGG	213
	Val Ala Asn Pro Gln Ala Glu Gly Gln Leu Gln Trp Leu Asn Arg Arg	
	20 25 30	
10	GCC AAT GCC CTC CTG GCC AAT GGC GTG GAG CTG AGA GAT AAC CAG CTG	261
	Ala Asn Ala Leu Leu Ala Asn Gly Val Glu Leu Arg Asp Asn Gln Leu	
	35 40 45	
	GTG GTG CCA TCA GAG GGC CTG TAC CTC ATC TAC TCC CAG GTC CTC TTC	309
	Val Val Pro Ser Glu Gly Leu Tyr Leu Ile Tyr Ser Gln Val Leu Phe	
	50 55 60	
15	AAG GGC CAA GGC TGC CCC TCC ACC CAT GTG CTC CTC ACC CAC ACC ATC	357
	Lys Gly Gln Gly Cys Pro Ser Thr His Val Leu Thr His Thr Ile	
	65 70 75 80	
20	AGC CGC ATC GCC GTC TCC TAC CAG ACC AAG GTC AAC CTC CTC TCT GCC	405
	Ser Arg Ile Ala Val Ser Tyr Gln Thr Lys Val Asn Leu Leu Ser Ala	
	85 90 95	
	ATC AAG AGC CCC TGC CAG AGG GAG ACC CCA GAG GGG GCT GAG GCC AAG	453
	Ile Lys Ser Pro Cys Gln Arg Glu Thr Pro Glu Gly Ala Glu Ala Lys	
	100 105 110	
25	CCC TGG TAT GAG CCC ATC TAT CTG GGA GGG GTC TTC CAG CTG GAG AAG	501
	Pro Trp Tyr Glu Pro Ile Tyr Leu Gly Gly Val Phe Gln Leu Glu Lys	
	115 120 125	
30	GGT GAC CGA CTC AGC GCT GAG ATC AAT CGG CCC GAC TAT CTC GAC TTT	549
	Gly Asp Arg Leu Ser Ala Glu Ile Asn Arg Pro Asp Tyr Leu Asp Phe	
	130 135 140	
	GCC GAG TCT GGG CAG GTC TAC TTT GGG ATC ATT GCC CTG TGAGGAGGAC	598
	Ala Glu Ser Gly Gln Val Tyr Phe Gly Ile Ile Ala Leu	
	145 150 155	
35	GAACATCCAA CCTTCCCAA CGCCTCCCCT GCCCAATCC CTTTATTACC CCCTCCTTCA	658
	GACACCCTCA ACCTCTTCTG GCTCAAAAAG AGAATTGGGG GCTTAGGGTC GGAACCCAAG	718
	CTTGGA CTCC TGTTGATAGA TCCAGTAATG ACCTCAGAAC TCCATCTGGA TTTGTTTACA	778
40	ACGCTCGGTT GCCGCCGGGC GTTTTTTATT GGTGAGAATC CAAGCTAGCT TGGCGAGATT	838
	TTCAGGAGCT AAGGAAGCTA AAATGGAGAA AAAAATCACT GGATATACCA CCGTTGATAT	898
	ATCCCAATGG CATCGTAAAG AACATTTTGA GGCATTTTCAG TCAGTTGCTC AATGTACCTA	958
45	TAACCAGACC GTTCAGCTGG ATATTACGGC CTTTTTAAAG ACCGTAAAGA AAAATAAGCA	1018
	CAAGTTTTAT CCGGCCCTTA TTCACATTCT TGCCCGCCTG ATGAATGCTC ATCCGGAATT	1078
	TCGTATGGCA ATGAAAGACG GTGAGCTGGT GATATGGGAT AGTGTTTACC CTTGTTACAC	1138
50	CGTTTTCCAT GAGCAAAC TG AAACGTTTTT ATCGCTCTGG AGTGAATACC ACGACGATTT	1198
55		

	CCGGCAGTTT CTACACATAT ATTGCAAGA TGTGGCGTGT TACGGTGAAA ACCTGGCCTA	1258
	TTTCCCTAAA GGGTTTATTG AGAATATGTT TTTCGTCTCA GCCAATCCCT GGGTGAGTTT	1318
5	CACCAGTTTT GATTTAAACG TGGCCAATAT GGACAACTTC TTCGCCCCG TTTTCACCAT	1378
	GGGCAAATAT TATACGCAAG GCGACAAGGT GCTGATGCCG CTGGCGATTC AGGTTCATCA	1438
	TGCCGTCTGT GATGGCTTCC ATGTCGGCAG AATGCTTAAT GAATTACAAC AGTACTGCGA	1498
10	TGAGTGGCAG GCGGGGGCGT AATTTTTTTA AGGCAGTTAT TGGTGCCCTT AAACGCCTGG	1558
	GGTAATGACT CTCTAGCTTG AGGCATCAAA TAAAACGAAA GGCTCAGTCG AAAGACTGGG	1618
	CCTTTCGTTT TATCTGTTGT TTGTCGGTGA ACGCTCTCCT GAGTAGGACA AATCCGCCGC	1678
15	TCTAGAGCTG CCTCGCGCGT TTCGGTGATG ACGGTGAAAA CCTCTGACAC ATGCAGCTCC	1738
	CGGAGACGGT CACAGCTTGT CTGTAAGCGG ATGCCGGGAG CAGACAAGCC CGTCAGGGCG	1798
	CGTCAGCGGG TGTTGGCGGG TGTCGGGGCG CAGCCATGAC CCAGTCACGT AGCGATAGCG	1858
20	GAGTGTATAC TGGCTTAACT ATGCGGCATC AGAGCAGATT GTACTGAGAG TGCACCATAT	1918
	GCGGTGTGAA ATACCGCACA GATGCGTAAG GAGAAAATAC CGCATCAGGC GCTCTCCGC	1978
	TTCTCTGCTC ACTGACTCGC TGCGCTCGGT CTGTCGGCTG CGGCGAGCGG TATCAGCTCA	2038
25	CTCAAAGGCG GTAATACGGT TATCCACAGA ATCAGGGGAT AACGCAGGAA AGAACATGTG	2098
	AGCAAAAGGC CAGCAAAAGG CCAGGAACCG TAAAAAGGCC GCGTTGCTGG CGTTTTTCCA	2158
	TAGGCTCCGC CCCCTGACG AGCATCACAA AAATCGACGC TCAAGTCAGA GGTGGCGAAA	2218
30	CCCGACAGGA CTATAAGAT ACCAGGCGTT TCCCCCTGGA AGCTCCCTCG TCGCTCTCC	2278
	TGTTCCGACC CTGCCGCTTA CCGGATACCT GTCCGCCTTT CTCCCTTCGG GAAGCGTGGC	2338
	GCTTTCTCAA TGCTCACGCT GTAGGTATCT CAGTTCGGTG TAGGTCGTTC GCTCCAAGCT	2398
35	GGGCTGTGTG CACGAACCCC CCGTTCAGCC CGACCGCTGC GCCTTATCCG GTAACATCG	2458
	TCTTGAGTCC AACCCGGTAA GACACGACTT ATCGCCACTG GCAGCAGCCA CTGGTAACAG	2518
	GATTAGCAGA GCGAGGTATG TAGGCGGTGC TACAGAGTTC TTGAAGTGGT GGCCTAACTA	2578
40	CGGCTACACT AGAAGGACAG TATTTGGTAT CTGCGCTCTG CTGAAGCCAG TTACCTTCGG	2638
	AAAAAGAGTT GGTAGCTCTT GATCCGGCAA ACAAACCACC GCTGGTAGCG GTGGTTTTTT	2698
	TGTTTGCAAG CAGCAGATTA CGCGCAGAAA AAAAGGATCT CAAGAAGATC CTTTGATCTT	2758
45	TTCTACGGGG TCTGACGCTC AGTGAACGA AAACCTACGT TAAGGGATTT TGGTCATGAG	2818
	ATTATCAAAA AGGATCTTCA CCTAGATCCT TTAAATTAA AAATGAAGTT TTAAATCAAT	2878
	CTAAAGTATA TATGAGTAAA CTTGGTCTGA CAGTTACCAA TGCTTAATCA GTGAGGCACC	2938
50	TATCTCAGCG ATCTGTCTAT TTCGTTTCATC CATAGCTGCC TGAATCCCCG TCGTGTAGAT	2998

55

AACTACGATA CGGGAGGGCT TACCATCTGG CCCAGTGCT GCAATGATAC CGCGAGACCC 3058
 ACGCTCACCG GCTCCAGATT TATCAGCAAT AAACCAGCCA GCCGGAAGGG CCGAGCGCAG 3118
 5 AAGTGGTCCT GCAACTTTAT CCGCCTCCAT CCAGTCTATT AATTGTTGCC GGAAGCTAG 3178
 AGTAAGTAGT TCGCCAGTTA ATAGTTTTCG CAACGTTGTT GCCATTGCTA CAGGCATCGT 3238
 GGTGTCACGC TCGTCGTTTG GTATGGCTTC ATTCAGCTCC GGTTCCCAAC GATCAAGGCG 3298
 10 AGTTACATGA TCCCCCATGT TGTGCAAAAA AGCGGTTAGC TCCTTCGGTC CTCCGATCGT 3358
 TGTCAGAAGT AAGTTGGCCG CAGTGTTATC ACTCATGGTT ATGGCAGCAC TGCATAATTC 3418
 TCTTACTGTC ATGCCATCCG TAAGATGCTT TTCTGTGACT GGTGAGTACT CAACCAAGTC 3478
 15 ATTCTGAGAA TAGTGTATGC GGCGACCGAG TTGCTCTTGC CCGGCGTCAA TACGGGATAA 3538
 TACCGCGCCA CATAGCAGAA CTTTAAAAGT GCTCATCATT GGAAAACGTT CTTCGGGGCG 3598
 AAAACTCTCA AGGATCTTAC CGCTGTTGAG ATCCAGTTCG ATGTAACCCA CTCGTGCACC 3658
 20 CAACTGATCT TCAGCATCTT TTACTTTTAC CAGCGTTTCT GGGTGAGCAA AAACAGGAAG 3718
 GCAAAATGCC GCAAAAAAGG GAATAAGGGC GACACGGAAA TGTTGAATAC TCATACTCTT 3778
 CCTTTTTCAA TATTATTGAA GCATTTATCA GGGTTATTGT CTCATGAGCG GATACATATT 3838
 25 TGAATGTATT TAGAAAAATA AACAAATAGG GGTCCGCGC ACATTTCCCC GAAAAGTGCC 3898
 ACCTGACGTC TAAGAAACCA TTATTATCAT GACATTAACC TATAAAAATA GCGTATCAC 3958
 GAGGCCCTTT CGTCTTCAC 3977

(2) INFORMATION FOR SEQ ID NO: 2:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 157 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 2:

40 Val Arg Ser Ser Ser Arg Thr Pro Ser Asp Lys Pro Val Ala His Val
 1 5 10 15
 Val Ala Asn Pro Gln Ala Glu Gly Gln Leu Gln Trp Leu Asn Arg Arg
 20 25 30
 45 Ala Asn Ala Leu Leu Ala Asn Gly Val Glu Leu Arg Asp Asn Gln Leu
 35 40 45
 Val Val Pro Ser Glu Gly Leu Tyr Leu Ile Tyr Ser Gln Val Leu Phe
 50 55 60
 55 Lys Gly Gln Gly Cys Pro Ser Thr His Val Leu Leu Thr His Thr Ile

	65		70		75		80									
	Ser	Arg	Ile	Ala	Val	Ser	Tyr	Gln	Thr	Lys	Val	Asn	Leu	Leu	Ser	Ala
					85					90					95	
5	Ile	Lys	Ser	Pro	Cys	Gln	Arg	Glu	Thr	Pro	Glu	Gly	Ala	Glu	Ala	Lys
				100					105					110		
	Pro	Trp	Tyr	Glu	Pro	Ile	Tyr	Leu	Gly	Gly	Val	Phe	Gln	Leu	Glu	Lys
10			115					120					125			
	Gly	Asp	Arg	Leu	Ser	Ala	Glu	Ile	Asn	Arg	Pro	Asp	Tyr	Leu	Asp	Phe
		130					135					140				
	Ala	Glu	Ser	Gly	Gln	Val	Tyr	Phe	Gly	Ile	Ile	Ala	Leu			
15		145				150					155					

(2) INFORMATION FOR SEQ ID NO: 3:

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 3740 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: circular

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

(iii) ANTI-SENSE: NO

(vi) ORIGINAL SOURCE:

(A) ORGANISM: Plasmid pREP4

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 3:

AAGCTTCACG	CTGCCGCAAG	CACTCAGGGC	GCAAGGGCTG	CTAAAGGAAG	CGGAACACGT	60
AGAAAGCCAG	TCCGCAGAAA	CGGTGCTGAC	CCCGGATGAA	TGTCAGCTAC	TGGGCTATCT	120
GGACAAGGGA	AAACGCAAGC	GCAAAGAGAA	AGCAGGTAGC	TTGCAGTGGG	CTTACATGGC	180
GATAGCTAGA	CTGGGCGGTT	TTATGGACAG	CAAGCGAACC	GGAATTGCCA	GCTGGGGCGC	240
CCTCTGGTAA	GGTTGGGAAG	CCCTGCAAAG	TAAACTGGAT	GGCTTTCTTG	CCGCCAAGGA	300
TCTGATGGCG	CAGGGGATCA	AGATCTGATC	AAGAGACAGG	ATGACGGTCG	TTTCGCATGC	360
TTGAACAAGA	TGGATTGCAC	GCAGGTTCTC	CGGCCGCTTG	GGTGGAGAGG	CTATTCGGCT	420
ATGACTGGGC	ACAACAGACA	ATCGGCTGCT	CTGATGCCGC	CGTGTTCCGG	CTGTCAGCGC	480
AGGGGCGCCC	GGTTCTTTTT	GTCAAGACCG	ACCTGTCCGG	TGCCCTGAAT	GAAGTGCAGG	540
ACGAGGCAGC	GCGGCTATCG	TGGCTGGCCA	CGACGGGCGT	TCCTTGCGCA	GCTGTGCTCG	600
ACGTTGTAC	TGAAGCGGGA	AGGGACTGGC	TGCTATTGGG	CGAAGTGCCG	GGGCAGGATC	660

	TCCTGTCATC TCACCTTGCT CCTGCCGAGA AAGTATCCAT CATGGCTGAT GCAATGCGGC	720
	GGCTGCATAC GCTTGATCCG GCTACCTGCC CATTCGACCA CCAAGCGAAA CATCGCATCG	780
5	AGCGAGCACG TACTCGGATG GAAGCCGGTC TTGTCGATCA GGATGATCTG GACGAAGAGC	840
	ATCAGGGGCT CGCGCCAGCC GAACTGTTCG CCAGGCTCAA GCGCGCATG CCCGACGGCG	900
	AGGATCTCGT CGTGACCCAT GCGGATGCCT GCTTGCCGAA TATCATGGTG GAAAATGGCC	960
10	GCTTTTCTGG ATTCATCGAC TGTGGCCGGC TGGGTGTGGC GGACCGCTAT CAGGACATAG	1020
	CGTTGGCTAC CCGTGATATT GCTGAAGAGC TTGGCGCGA ATGGGCTGAC CGCTTCCTCG	1080
	TGCTTTACGG TATCGCCGCT CCCGATTGCG AGCGCATCGC CTTCTATCGC CTTCTTGACG	1140
15	AGTTCTTCTG AGCGGGACTC TGGGGTTCTGA AATGACCGAC CAAGCGACGC CCAACCTGCC	1200
	ATCACGAGAT TTCGATTCCA CCGCCGCCTT CTATGAAAGG TTGGGCTTCG GAATCGTTTT	1260
	CCGGGACGCC GGCTGGATGA TCCTCCAGCG CGGGGATCTC ATGCTGGAGT TCTTCGCCCA	1320
20	CCCCGGGCTC GATCCCCTCG CGAGTTGGTT CAGCTGCTGC CTGAGGCTGG ACGACCTCGC	1380
	GGAGTTCTAC CGGCAGTGCA AATCCGTCGG CATCCAGGAA ACCAGCAGCG GCTATCCGCG	1440
	CATCCATGCC CCCGAACTGC AGGAGTGGGG AGGCACGATG GCCGCTTTGG TCGACAATTC	1500
25	GCGCTAACTT ACATTAATTG CGTTGCGCTC ACTGCCCGCT TTCCAGTCGG GAAACCTGTC	1560
	GTGCCAGCTG CATTAATGAA TCGGCCAACG CGCGGGGAGA GGCGGTTTGC GTATTGGGCG	1620
	CCAGGGTGGT TTTTCTTTTC ACCAGTGAGA CGGGCAACAG CTGATTGCCC TTCACCGCCT	1680
30	GGCCCTGAGA GAGTTGCAGC AAGCGGTCCA CGCTGGTTTG CCCAGCAGG CGAAAATCCT	1740
	GTTTGATGGT GGTTAACGGC GGGATATAAC ATGAGCTGTC TTCGGTATCG TCGTATCCCA	1800
	CTACCGAGAT ATCCGCACCA ACGCGCAGCC CGGACTCGGT AATGGCGCGC ATTGCGCCCA	1860
35	GCGCCATCTG ATCGTTGGCA ACCAGCATCG CAGTGGGAAC GATGCCCTCA TTCAGCATTT	1920
	GCATGGTTTG TTGAAAACCG GACATGGCAC TCCAGTCGCC TTCCCGTTCC GCTATCGGCT	1980
	GAATTTGATT GCGAGTGAGA TATTTATGCC AGCCAGCCAG ACGCAGACGC GCCGAGACAG	2040
40	AACTTAATGG GCCCCTAAC AGCGCGATTT GCTGGTGACC CAATGCGACC AGATGCTCCA	2100
	CGCCAGTCG CGTACCGTCT TCATGGGAGA AAATAATACT GTTGATGGGT GTCTGGTCAG	2160
	AGACATCAAG AAATAACGCC GGAACATTAG TGCAGGCAGC TTCCACAGCA ATGGCATCCT	2220
45	GGTCATCCAG CGGATAGTTA ATGATCAGCC CACTGACGCG TTGCGCGAGA AGATTGTGCA	2280
	CCGCCGCTTT ACAGGCTTCG ACGCCGCTTC GTTCTACCAT CGACACCACC ACGCTGGCAC	2340
	CCAGTTGATC GCGCGGAGAT TTAATCGCCG CGACAATTG CGACGGCGCG TGCAGGGCCA	2400
50	GACTGGAGGT GGCAACGCCA ATCAGCAACG ACTGTTTGCC CGCCAGTTGT TGTGCCACGC	2460

GGTTGGAAT GTAATTCAGC TCCGCCATCG CCGCTTCCAC TTTTCCCGC GTTTTCGCAG 2520
 AAACGTGGCT GGCCTGGTTC ACCACGCGGG AAACGGTCTG ATAAGAGACA CCGGCATACT 2580
 5 CTGCGACATC GTATAACGTT ACTGGTTTCA CATTCACCAC CCTGAATTGA CTCTCTTCCG 2640
 GCGCGTATCA TGCCATACCG CGAAAGGTTT TGCGCCATTC GATGGTGTCA ACGTAAATGC 2700
 ATGCCGCTTC GCCTTCGCGC GCGAATTGTC GACCCTGTCC CTCCTGTTCA GCTACTGACG 2760
 10 GGGTGGTGGC TAACGGCAAA AGCACCGCCG GACATCAGCG CTAGCGGAGT GTATACTGGC 2820
 TTAATATGTT GGCCTGATG AGGGTGTGAG TGAAGTGCTT CATGTGGCAG GAGAAAAAAG 2880
 GCTGCACCGG TGCCTCAGCA GAATATGTGA TACAGGATAT ATTCCGCTTC CTCGCTCACT 2940
 15 GACTCGCTAC GCTCGGTCGT TCGACTGCGG CGAGCGGAAA TGGCTTACGA ACGGGGCGGA 3000
 GATTTCTTGG AAGATGCCAG GAAGATACTT AACAGGGAAG TGAGAGGGCC GCGGCAAAGC 3060
 CGTTTTTCCA TAGGCTCCGC CCCCTGACA AGCATCACGA AATCTGACGC TCAAATCAGT 3120
 20 GGTGGCGAAA CCCGACAGGA CTATAAAGAT ACCAGGCGTT TCCCCTGGCG GCTCCCTCGT 3180
 GCGCTCTCCT GTTCTGCTT TCGGTTTAC CCGTGTGATT CCGCTGTTAT GGCCGCGTTT 3240
 GTCTCATTCC ACGCCTGACA CTCAGTTCCG GGTAGGCAGT TCGCTCCAAG CTGGACTGTA 3300
 25 TGCACGAACC CCCCGTTCAG TCCGACCGCT GCGCCTTATC CGGTAATAT CGTCTTGAGT 3360
 CCAACCCGGA AAGACATGCA AAAGCACCAC TGGCAGCAGC CACTGGTAAT TGATTTAGAG 3420
 GAGTTAGTCT TGAAGTCATG CGCCGGTTAA GGCTAAACTG AAAGGACAAG TTTTGGTGAC 3480
 30 TGCCTCCTC CAAGCCAGTT ACCTCGGTTT AAAGAGTTGG TAGCTCAGAG AACCTTCGAA 3540
 AAACCGCCCT GCAAGGCGGT TTTTTCGTTT TCAGAGCAAG AGATTACGCG CAGACCAAAA 3600
 CGATCTCAAG AAGATCATCT TATTAATCAG ATAAAATATT TCTAGATTTC AGTGCAATTT 3660
 35 ATCTCTTCAA ATGTAGCACC TGAAGTCAGC CCCATACGAT ATAAGTTGTT AATTCTCATG 3720
 TTTGACAGCT TATCATCGAT 3740

(2) INFORMATION FOR SEQ ID NO: 4:

- 40 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 22 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear
- 45 (ii) MOLECULE TYPE: DNA (genomic)
- (iii) HYPOTHETICAL: NO
- (iii) ANTI-SENSE: NO
- 50 (vi) ORIGINAL SOURCE:
 (A) ORGANISM: Primer 17/F

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 4:

GGCGTATCAC GAGGCCCTTT CG

22

5 (2) INFORMATION FOR SEQ ID NO: 5:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 28 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 10 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

15 (iii) ANTI-SENSE: NO

(vi) ORIGINAL SOURCE:
 (A) ORGANISM: Primer 46/M12

20 (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 5:

GCGAAAGTTG AGATAGTCGG GCCGATTG

28

25 (2) INFORMATION FOR SEQ ID NO: 6:

(i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 22 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 30 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: NO

35 (iii) ANTI-SENSE: NO

(vi) ORIGINAL SOURCE:
 (A) ORGANISM: Primer 29/MR2

40 (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 6:

GAGTCTGGGC AGGTCTACTT TG

22

(2) INFORMATION FOR SEQ ID NO: 7:

45 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 22 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

50 (ii) MOLECULE TYPE: DNA (genomic)

55

(iii) HYPOTHETICAL: NO

(iii) ANTI-SENSE: NO

(vi) ORIGINAL SOURCE:

(A) ORGANISM: Primer 17/0

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 7:

CATTACTGGA TCTATCAACA GG

22

Claims

1. A human TNF α mutein having higher binding affinity for human p75-TNF receptor than for human P55 TNF receptor or a pharmaceutically acceptable salt thereof.
2. A compound according to claim 1 comprising at least one different amino acid to wild-type human TNF α at a position corresponding to position 33, 65, 67, 75, 143, 145 and/or 147 of wild-type human TNF α .
3. A compound according to claim 2, wherein the mutein comprises at least one different amino acid at a position corresponding to position 143 and/or 145 of wild-type human TNF α .
4. A compound according to claim 2, wherein the mutein comprises at least one of the following amino acid changes at a position corresponding to the position indicated for the wild-type sequence:

A33T

K65A

K65W

Q67K

Q67T

Q67Y

L75H

L75W

D143N

D143E

D143F

D143W

D143Y

D143V

D143V - F144L - A145S

D143N - A145R

D143V - A145S

A145R

A145D

A145G

A145H

A145K

A145F

A145S

A145T

A145W

A145Y

A145V

E146R

S147L

5. A compound according to claim 4, wherein the mutein comprises at least one of the following amino acid changes at a position corresponding to the position indicated for the wild-type sequence:
K65W
D143N
5 D143E
D143F
D143W
D143Y
D143V
10 D143V - F144L - A145S
D143N - A145R
D143V - A145S
A145R
A145H
15 A145K
A145F
A145W
A145Y
- 20 6. A compound according to claim 5, wherein the mutein comprises at least one of the following amino acid changes at a position corresponding to the position indicated for the wild-type sequence:
D143N
D143E
D143F
25 D143W
D143Y
D143V
D143V - F144L - A145S
D143N - A145R
30 D143V - A145S
A145R
A145K
A145F
A145W
35 A145Y
7. A compound according to any preceding claim, wherein the mutein comprises at least one of the following amino acid changes at a position corresponding to the position indicated for the wild-type sequence:
40 D143N
D143Y
A145F
A145R
A145W
45 D143N - A145R
8. A compound as claimed in any one of claims 1-7 in pegylated form.
9. A DNA sequence coding for a mutein according to any of claims 1 to 7.
- 50 10. A vector comprising a DNA sequence according to claim 9.
11. A host cell comprising a vector according to claim 10.
- 55 12. An RNA sequence complementary to a DNA sequence according to claim 10.
13. A compound according to any of claims 1 to 8 for use in the treatment of the human or animal body by surgery, or therapy or for use in a diagnostic method.

14. A process for the preparation of a compound as claimed in any of claims 1 to 8 which comprises cultivating a host cell as claimed in claim 11 in a suitable medium, and then purifying the mutein and optionally pegylating the so purified mutein or preparing a salt thereof by methods known in the art.

5 15. A pharmaceutical composition comprising a compound according to any of claims 1-8, in combination with a pharmaceutical acceptable carrier.

16. The use of a compound as claimed in any one of claims 1-8 for the treatment of the human or animal body by surgery or therapy or in a diagnostic method.

10

15

20

25

30

35

40

45

50

55

FIG. 1A

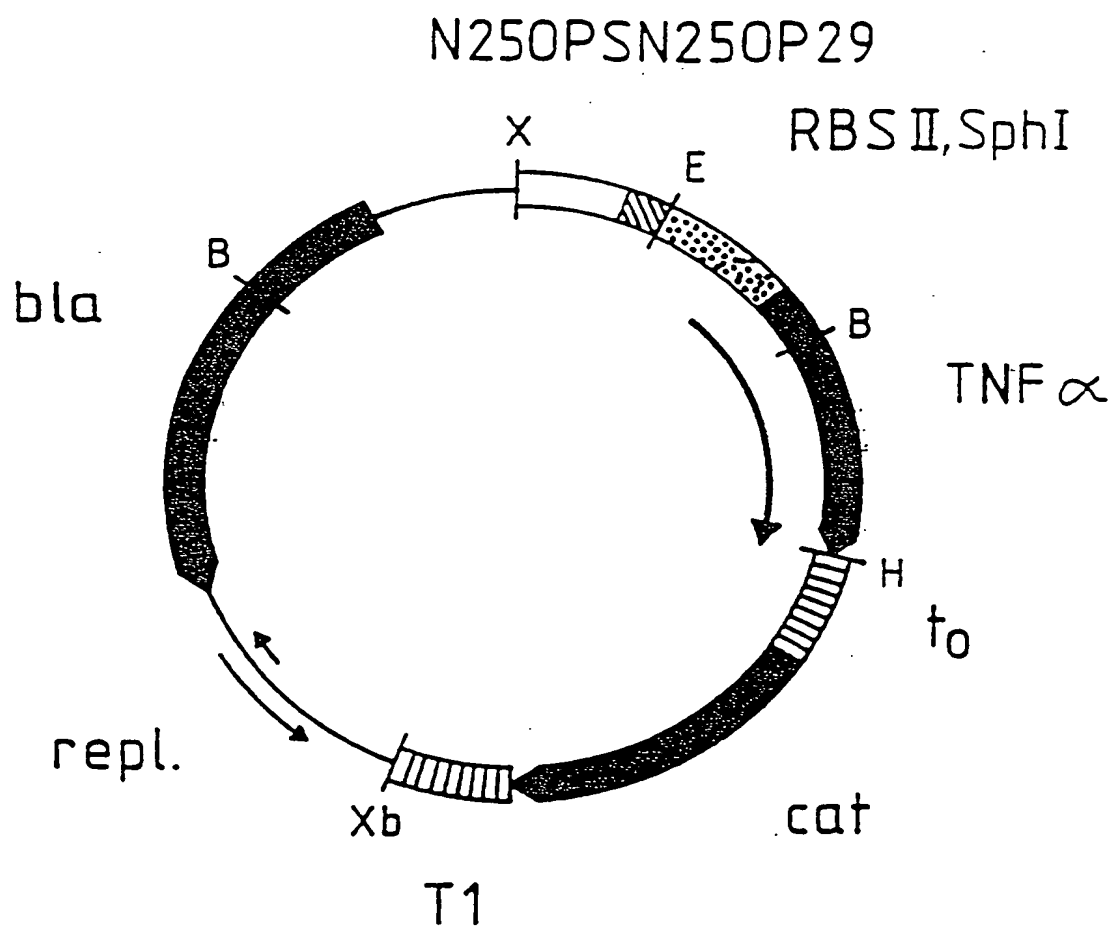


FIG. 1B/1

XhoI
1 CTCGAGAAAT CATAAAAAT TTATTTGCTT TGTGAGCGGA TAACAATTAT

EcoRI
51 AATAGATTCA ATTGTGAGCG GATAACAATT TCACACAGAA TTCATTAAAG

101 AGGAGAAATT AAGCATGGTC AGATCATCTT CTCGAACCCC GAGTGACAAG
Val ArgSerSerS erArgThrPr oSerAspLys
1 11

151 CCTGTAGCCC ATGTTGTGCG GAACCCTCAA GCTGAGGGGC AGCTCCAGTG
ProValAlaH isValValAl aAsnProGln AlaGluGlyG lnLeuGlnTr
21

BglI
201 GCTGAACCGC CGGGCCAATG CCCTCCTGGC CAATGGCGTG GAGCTGAGAG
pLeuAsnArg ArgAlaAsnA laLeuLeuAl aAsnGlyVal GluLeuArgA
31 41

251 ATAACCAGCT GGTGGTGCCA TCAGAGGGCC TGTACCTCAT CTACTCCCAG
spAsnGlnLe uValValPro SerGluGlyL erTyrLeuIl eTyrSerGln
51 61

301 GTCTCTTCA AGGGCCAAGG CTGCCCCCTCC ACCCATGTGC TCCTCACCCA
ValLeuPheL ysGlyGlnGl yCysProSer ThrHisValL euLeuThrHi
71

351 CACCATCAGC CGCATGCGCG TCTCTTACCA GACCAAGGTC AACCTCCTCT
sThrIleSer ArgIleAlaV alSerTyrGl nThrLysVal AsnLeuLeuS
81 91

401 CTGCCATCAA GAGCCCCCTGC CAGAGGGAGA CCCCAGAGGG GGCTGAGGCC
erAlaIleLy sSerProCys GlnArgGluT hrProGluGl yAlaGluAla
101 111

451 AAGCCCTGGT ATGAGCCCAT CTATCTGGGA GGGGTCTTCC AGCTGGAGAA
LysProTrpT yrGluProIl eTyrLeuGly GlyValPheG lnLeuGluLy
121

501 GGGTGACCGA CTCAGCGCTG AGATCAATCG GCCCGACTAT CTCGACTTTG
sGlyAspArg LeuSerAlaG luIleAsnAr gProAspTyr LeuAspPheA
131 141

551 CCGAGTCTGG GCAGGTCTAC TTTGGGATCA TTGCCCTGTG AGGAGGACGA
laGluSerGl yGlnValTyr PheGlyIleI leAlaLeu
151 157

601 ACATCCAACC TTCCCAAACG CCTCCCCTGC CCCAATCCCT TTATTACCCC

651 CTCCTTCAGA CACCCTCAAC CTCTTCTGGC TCAAAAAGAG AATTGGGGGC

HindIII
701 TTAGGGTCGG AACCCAGCT TGGACTCCTG TTGATAGATC CAGTAATGAC

751 CTCAGAACTC CATCTGGATT TGTCAGAAC GCTCGGTTGC CGCGGGCGT

FIG. 1B/2

801 TTTTATTGG TGAGAATCCA AGCTAGCTTG GCGAGATTTT CAGGAGCTAA
 851 GGAAGCTAAA ATGGAGAAAA AAATCACTGG ATATACCACC GTTGATATAT
 901 CCCAATGGCA TCGTAAAGAA CATTMTGAGG CATTTCAGTC AGTTGCTCAA
 951 TGTACCTATA ACCAGACCGT TCAGCTGGAT ATTACGGCCT TTTTAAAGAC
 1001 CGTAAAGAAA AATAAGCACA AGTTTATCC GGCCTTTATT CACATTCTTG
 1051 CCGCCTGAT GAATGCTCAT CCGGAATTC GTATGGCAAT GAAAGACGGT
 1101 GAGCTGGTGA TATGGGATAG TGTTCACCTT TGTTACACCG TMTCCATGA
 1151 GCAAACAGAA ACGTMTTCAT CGCTCTGGAG TGAATACCAC GACGATTTCC
 1201 GGCAGTTTCT ACACATATAT TCGCAAGATG TGGCGTGTTA CGGTGAAAAC
 1251 CTGGCCTATT TCCCTAAAGG GTTATTGAG AATATGTTTT TCGTCTCAGC
 1301 CAATCCCTGG GTGAGTTTCA CCAGTTTGA TTAAACGTG GCCAATATGG
 1351 ACAACTTCTT CGCCCCCGTT TTCACCATGG GCAAATATTA TAOGCAAGGC
 1401 GACAAGGTGC TGATGCCGCT GCGATTTCAG GTTCATCATG CCGTCTGTGA
 1451 TGGCTTCCAT GTGGGCAGAA TGCTTAATGA ATTACAACAG TACTGCGATG
 1501 AGTGGCAGGG CGGGGGGTAA TTTTTTAAAG GCAGTTATTG GTGCCCTTAA
 1551 AOGCCTGGGG TAATGACTCT CTAGCTTGAG GCATCAAATA AAACGAAAGG
 1601 CTCAGTOGAA AGACTGGGCC TTCTGTTTAA TCTGTGTGTT GTGGGTGAAC
 XbaI
 1651 GCTCTCCTGA GTAGGACAAA TCCGCCGCTC TAGAGCTGCC TCGCGCGTTT
 1701 CCGTGATGAC GGTGAAAACC TCTGACACAT GCAGCTCCCG GAGACGGTCA
 1751 CAGCTTGTCT GTAAGCGGAT GCGGGGAGCA GACAAGCCCG TCAGGGGCGG
 1801 TCAGCGGGTG TTGGCGGGTG TCGGGGGGCA GCCATGACCC AGTCACGTAG
 1851 CGATAGCGGA GTGTATACTG GCTTAACAT GCGGCATCAG AGCAGATTGT
 1901 ACTGAGAGTG CACCATATGC GGTGTGAAAT ACCGCACAGA TCGGTAAAGGA
 1951 GAAAATACCG CATCAGGCGC TCTTCGCTT CCTCGCTCAC TGACTCGCTG
 2001 CGCTCGGTCT GTGGGCTGCG GCGAGCGGTA TCAGCTCACT CAAAGGCGGT
 2051 AATACGGTTA TCCACAGAAT CAGGGGATAA CGCAGGAAAG AACATGTGAG
 2101 CAAAAGGCCA GCAAAGGCC AGGAACCGTA AAAAGGCCGC GTTGCTGGCG

FIG. 1B/3

2151 TTTTTCATA GGCTCCGCCC CCCTGACGAG CATCACAAAA ATCGACGCTC
 2201 AAGTCAGAGG TGGCGAAACC CGACAGGACT ATAAAGATAC CAGGCGTTTC
 2251 CCCCTGGAAG CTCCTCTGTG CGCTCTCCTG TTCCGACCCCT GCGGCTTACC
 2301 GGATACCTGT CCGCCTTTCT CCCTTCGGGA AGCGTGGCGC TTTCTCAATG
 2351 CTCACGCTGT AGGTATCTCA GTTCGGTGTA GGTCGTTCCG TCCAAGCTGG
 2401 GCTGTGTGCA CGAACCCCCC GTTCAGCCCG ACCGCTGCGC CTTATCCGGT
 2451 AACTATCGTC TTGAGTCCAA CCCGTAAGA CACGACTTAT CGCCACTGGC
 2501 AGCAGCCACT GGTAACAGGA TTAGCAGAGC GAGGTATGTA GGCGGTGCTA
 2551 CAGAGTTCTT GAAGTGGTGG CCTAACTACG GCTACACTAG AAGGACAGTA
 2601 TTTGGTATCT GCGCTCTGCT GAAGCCAGTT ACCTTCGGAA AAAGAGTTGG
 2651 TAGCTCTTGA TCCGGCAAAC AAACCACCGC TGGTAGCGGT GGTTTTTTTG
 2701 TTTGCAAGCA GCAGATTACG CGCAGAAAAA AAGGATCTCA AGAAGATCCT
 2751 TTGATCTTTT CTACGGGGTC TGACGCTCAG TGGAAACGAA ACTCACGTGA
 2801 AGGGATTTTG GTCATGAGAT TATCAAAAAG GATCTTCACC TAGATCCTTT
 2851 TAAATTAAAA ATGAAGTTTT AAATCAATCT AAAGTATATA TGAGTAAACT
 2901 TGGTCTGACA GTTACCAATG CTTAATCAGT GAGGCACCTA TCTCAGCGAT
 2951 CTGTCTATTT CGTTCATCCA TAGCTGCCTG ACTCCCCGTC GTGTAGATAA
 3001 CTACGATAAG GGAGGGCTTA CCATCTGGCC CCAGTGCTGC AATGATACCG
 3051 CGAGACCCAC GCTCACCGGC TCCAGATTGA TCAGCAATAA ACCAGCCAGC

 BglI
 3101 CGGAAGGGCC GAGCGCAGAA GTGGTCCCTG AACTTATCC GCTCCATCC
 3151 AGTCTATTAA TTGTTGCCGG GAAGCTAGAG TAAGTAGTTC GCCAGTTAAT
 3201 AGTTTGCGCA ACGTTGTTGC CATTGCTACA GGCATCGTGG TGTCACGCTC
 3251 GTCGTTTGGT ATGGCTTCAT TCAGCTCCGG TTCCCAACGA TCAAGGCGAG
 3301 TTACATGATC CCCCATGTTG TGCAAAAAG CGGTTAGCTC CTTCCGTCCT
 3351 CCGATCGTTG TCAGAAGTAA GTTGGCCGCA GTGTATCAC TCATGGTTAT
 3401 GGCAGCACTG CATAATTCTC TTAGTTCAT GCCATCCGTA AGATGCTTTT
 3451 CTGTGACTGG TGAGTACTCA ACCAAGTCAT TCTGAGAATA GTGTATGCCG

FIG. 1B/4

3501 CGACCGAGTT GCTCTTGCCC GCGTCAATA CGGGATAATA CCGCGCCACA
3551 TAGCAGAACT TTAAAAGTGC TCATCATTTG AAAACGTTCT TCGGGGCGAA
3601 AACTCTCAAG GATCTTACCG CTGTTGAGAT CCAGTTGAT GTAACCCACT
3651 CGTGCACCCA ACTGATCTTC AGCATCTTTT ACTTTCACCA GCGTTTCTGG
3701 GTGAGCAAAA ACAGGAAGGC AAAATGCCGC AAAAAGGGA ATAAGGGCGA
3751 CACGGAAATG TTGAATACTC ATACTCTTCC TTTTCAATA TTATTGAAGC
3801 ATTTATCAGG GTTATTGTCT CATGAGCGGA TACATATTG AATGTATTTA
3851 GAAAAATAAA CAAATAGGGG TTCCGCGCAC ATTTCCCCGA AAAGTGCCAC
3901 CTGACGTCTA AGAAACCATT ATTATCATGA CATTAACCTA TAAAAATAGG
3951 CGTATCACGA GGCCCTTTTG TCTTCAC

FIG. 2A

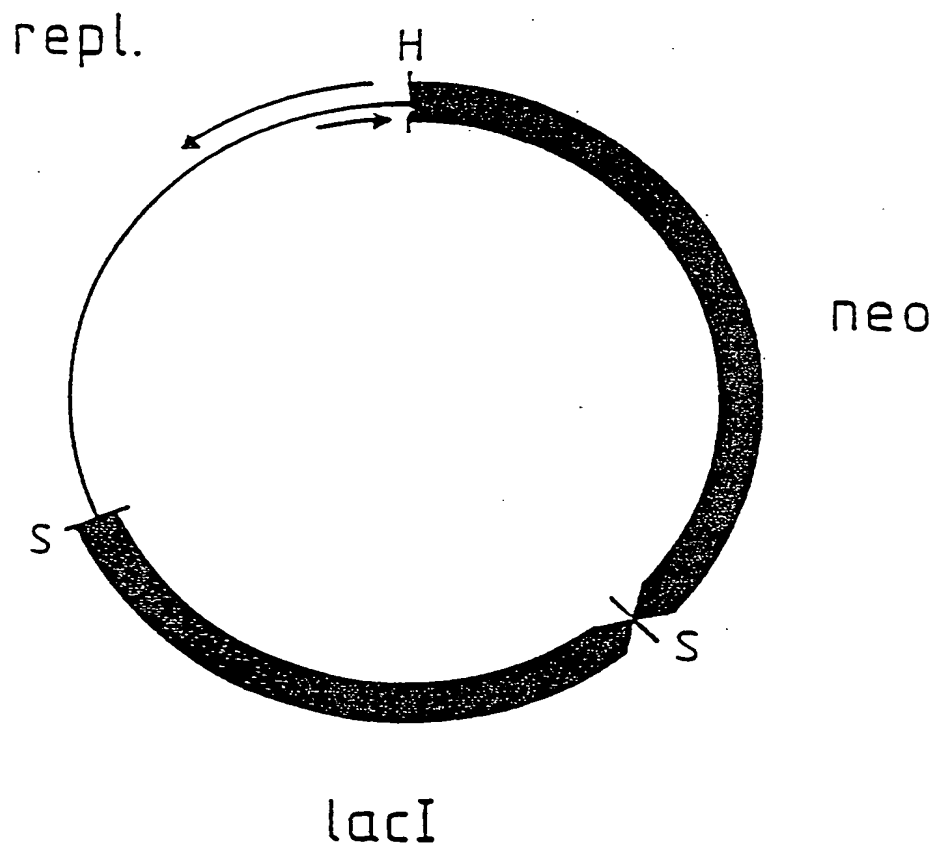


FIG. 2B/1

HindIII

1 AAGCTTCACG CTGCCGCAAG CACTCAGGGC GCAAGGGCTG CTAAAGGAAG

51 CGGAACACGT AGAAAGCCAG TCCGCAGAAA CCGTGCTGAC CCCGGATGAA

101 TGTCAGCTAC TGGGCTATCT GGACAAGGGA AAACGCAAGC GCAAAGAGAA

151 AGCAGGTAGC TTGCAGTGGG CTTACATGGC GATAGCTAGA CTGGGCGGTT

201 TTATGGACAG CAAGCGAACC GGAATTGCCA GCTGGGGGCG CCTCTGGTAA

251 GGTGGGAAG CCTGCAAAG TAAACTGGAT GGCTTTCTTG CGCCCAAGGA

301 TCTGATGGCG CAGGGGATCA AGATCTGATC AAGAGACAGG ATGACGGTCG

351 TTTCGCATGC TTGAACAAGA TGGATTGCAC GCAGGTTCTC CGGCGGCTTG

401 GGTGGAGAGG CTATTGGGCT ATGACTGGGC ACAACAGACA ATCGGCTGCT

451 CTGATGCGC CGTGTTCCGG CTGTCAGGC AGGGGCGCCC GGTTCTTTTT

501 GTCAAGACCG ACCTGTCCGG TGCCCTGAAT GAACTGCAGG ACGAGGCAGC

551 GGGGCTATCG TGGCTGGCCA CGACGGGGGT TCCTTGCGCA GCTGTGCTCG

601 ACGTTGTAC TGAAGCGGGA AGGGACTGGC TGCTATTGGG CGAAGTGCCG

651 GGGCAGGATC TCCTGTATC TCACCTTGCT CCTGCGAGA AAGTATCCAT

701 CATGGCTGAT GCAATGCGGC GGCTGCATAC GCTTGATCG GCTACCTGCC

751 CATTCGACCA CCAAGCGAAA CATCGCATCG AGCGAGCAGG TACTCGGATG

801 GAAGCCGGTC TTGTGATCA GGATGATCTG GAAGAAGAGC ATCAGGGGCT

851 CGGCCAGCC GAACTGTTCC CCAGGCTCAA GGCGCGCATG CCGAAGGGCG

901 AGGATCTCGT CGTGACCCAT GGCGATGCCT GCTTGCGAA TATCATGGTG

951 GAAAATGGCC GCTTTTCTGG ATTCAATGAC TGTGGCGGC TGGGTGTGGC

1001 GGACCGCTAT CAGGACATAG CGTTGGCTAC CCGTGATATT GCTGAAGAGC

1051 TTGGCGGCGA ATGGGCTGAC CGCTTCCTCG TGCTTTAAGG TATCGCGGCT

1101 CCGATTCCG AGCGCATCGC CTTCTATCGC CTTCTTGAGG AGTTCTTCTG

1151 AGCGGACTC TGGGGTTGGA AATGACCGAC CAAGCGACGC CCAACCTGCC

1201 ATCAGGAGAT TTCGATTCCA CCGCGCCCTT CTATGAAAGG TTGGGCTTCG

1251 GAATCGTTTT CCGGGACGCC GGCTGGATGA TCCTCCAGCG CGGGGATCTC

1301 ATGCTGGAGT TCTTCGCCCC CCCCGGGCTC GATCCCCTCG CGAGTTGGTT

FIG 2B/2

1351 CAGCTGCTGC CTGAGGCTGG ACGACCTCGC GGAGTTCTAC CGGCAGTGCA
 1401 AATCCGTCCG CATCCAGGAA ACCAGCAGCG GCTATCCGCG CATCCATGCC
 1451 CCCGAACTGC AGGAGTGGGG AGGCACGATG GCCGCTTTGG TCGACAATTC
 1501 GCGCTAACTT ACATTAATTG CGTTGCGCTC ACTGCCCGCT TTCCAGTCGG
 1551 GAAACCTGTC GTGCCAGCTG CATTAATGAA TCGGCCAACG CGCGGGGAGA
 1601 GGCGGTTTGC GTATTGGGCG CCAGGGTGGT TTTTCTTTTC ACCAGTGAGA
 1651 CGGGCAACAG CTGATTGCCC TTCACCGCCT GGCCCTGAGA GAGTTGCAGC
 1701 AAGCGGTCCA CGCTGGTTTG CCCCAGCAGG CGAAAATCCT GTTGTATGGT
 1751 GGTTAACGGC GGGATATAAC ATGAGCTGTC TTCGGTATCG TCGTATCCCA
 1801 CTACCGAGAT ATCCGCACCA ACGCGCAGCC CGGACTCGGT AATGGCGCGC
 1851 ATTGCGCCCA GCGCCATCTG ATCGTTGGCA ACCAGCATCG CAGTGGGAAC
 1901 GATGCCCTCA TTCAGCATTT GCATGGTTTG TTGAAAACCG GACATGGCAC
 1951 TCCAGTCGCC TTCCCGTTCC GCTATCGGCT GAATTTGATT GCGAGTGAGA
 2001 TATTTATGCC AGCCAGCCAG ACGCAGACGC GCGAGACAG AACTTAATGG
 2051 GCCCGCTAAC AGCGGATTTT GCTGGTGACC CAATGCGACC AGATGCTCCA
 2101 CGCCAGTCG CGTACCGTCT TCATGGGAGA AAATAATACT GTTGTATGGT
 2151 GTCTGGTCAG AGACATCAAG AAATAACGCC GGAACATTAG TGCAGGCAGC
 2201 TTCCACAGCA ATGGCATCCT GGTATCCAG CGGATAGTAA ATGATCAGCC
 2251 CACTGACGCG TTGCGCGAGA AGATTGTGCA CCGCCGCTTT ACAGGCTTCG
 2301 ACGCCGCTTC GTTCTACCAT CGACACCACC ACGCTGGCAC CCAGTTGATC
 2351 GGCGCGAGAT TTAATCGCCG CGACAATTTG CGACGGCGCG TGCAGGGCCA
 2401 GACTGGAGGT GGCAACGCCA ATCAGCAACG ACTGTTTGCC CGCCAGTTGT
 2451 TGTGCCACGC GGTGGGAAT GTAATTCAGC TCCGCCATCG CCGCTTCCAC
 2501 TTTTCCCGC GTTTTCGAG AAACGTGGCT GGCTGGTTC ACCACGCGGG
 2551 AAACGGTCTG ATAAGAGACA CCGGCATACT CTGCGACATC GTATAACGTT
 2601 ACTGGTTTCA CATTCACCAC CCTGAATTGA CTCTCTCCG GCGCTATCA
 2651 TGCCATACCG CGAAAGGTTT TCGCCATTC GATGGTGTCA ACGTAAATGC

FIG. 2B/3

SalI

```

2701  ATGCCGCTTC  GCCTTCGCGC  GCGAATTGTC  GACCCTGTCC  CTCCTGTTCA
2751  GCTACTGACG  GGGTGGTGCG  TAACGGCAAA  AGCACCGCCG  GACATCAGCG
2801  CTAGCGGAGT  GTATACTGGC  TTACTATGTT  GGCAC TGATG  AGGGTGTCAG
2851  TGAAGTGCTT  CATGTGGCAG  GAGAAAAAAG  GCTGCACCCG  TCGGTCAGCA
2901  GAATATGTGA  TACAGGATAT  ATTCCGCTTC  CTCGCTCACT  GACTCGCTAC
2951  GCTCGGTCGT  TCGACTGCGG  CGAGCGGAAA  TGGCTTACGA  ACGGGGCGGA
3001  GATTTCTCTG  AAGATGCCAG  GAAGATACTT  AACAGGGAAG  TGAGAGGGCC
3051  GCGGCAAAGC  CGTTTTTCCA  TAGGCTCCGC  CCCCTGACA  AGCATCACGA
3101  AATCTGACGC  TCAAATCAGT  GGTGGCGAAA  CCCGACAGGA  CTATAAAGAT
3151  ACCAGGCGTT  TCCCCTGGCG  GCTCCCTCGT  GCGCTCTCCT  GTTCTGCTCT
3201  TTCGGTTTAC  CGGTGTCAAT  CCGCTGTTAT  GGCCGCGTTT  GTCTCATGCC
3251  ACGCCTGACA  CTCAGTTCCG  GGTAGGCAGT  TCGCTCCAAG  CTGGACTGTA
3301  TGCACGAACC  CCCCGTTCAG  TCCGACCGCT  GCGCCTTATC  CGGTAACTAT
3351  CGTCTTGAGT  CCAACCCGGA  AAGACATGCA  AAAGCACCAC  TGGCAGCAGC
3401  CACTGGTAAT  TGATTTAGAG  GAGTTAGTCT  TGAAGTCATG  CGCCGGTTAA
3451  GGCTAAACTG  AAAGGACAAG  TTTTGGTGAC  TCGCTCCTC  CAAGCCAGTT
3501  ACCTCGGTTT  AAAGAGTTGG  TAGCTCAGAG  AACCTTCGAA  AAACCGCCCT
3551  GCAAGGCGGT  TTTTTCGTTT  TCAGAGCAAG  AGATTACGCG  CAGACCAAAA
3601  CGATCTCAAG  AAGATCATCT  TATTAATCAG  ATAAAATATT  TCTAGATTTT
3651  AGTGCAATTT  ATCTCTTCAA  ATGTAGCACC  TGAAGTCAGC  CCCATACGAT
3701  ATAAGTTGTT  AATTCTCATG  TTTGACAGCT  TATCATCGAT

```

FIG. 3

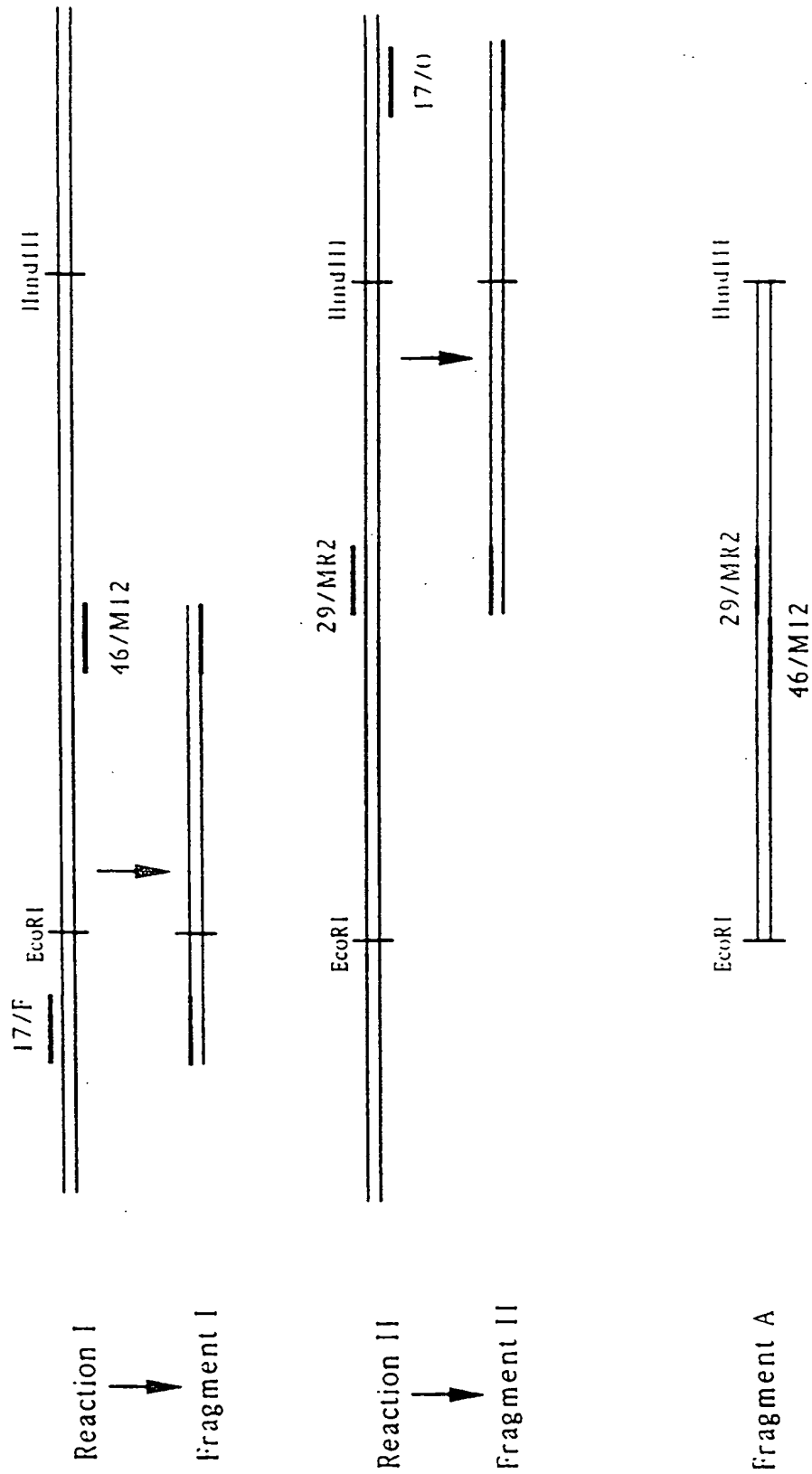
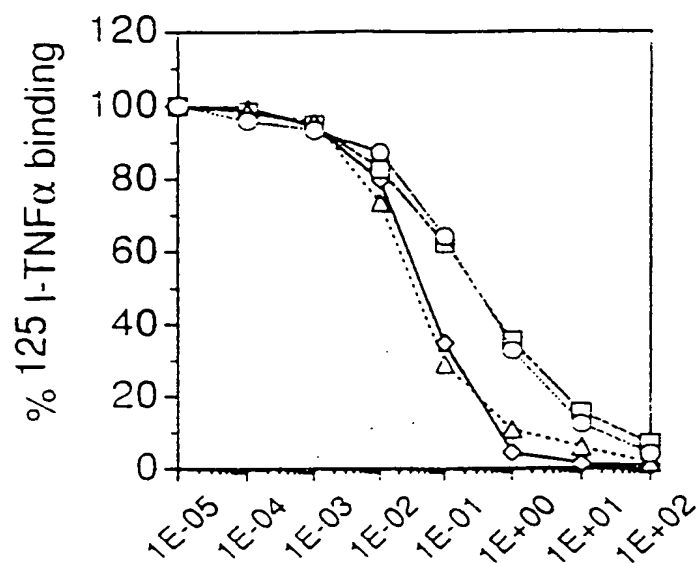
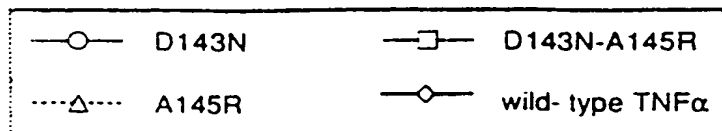
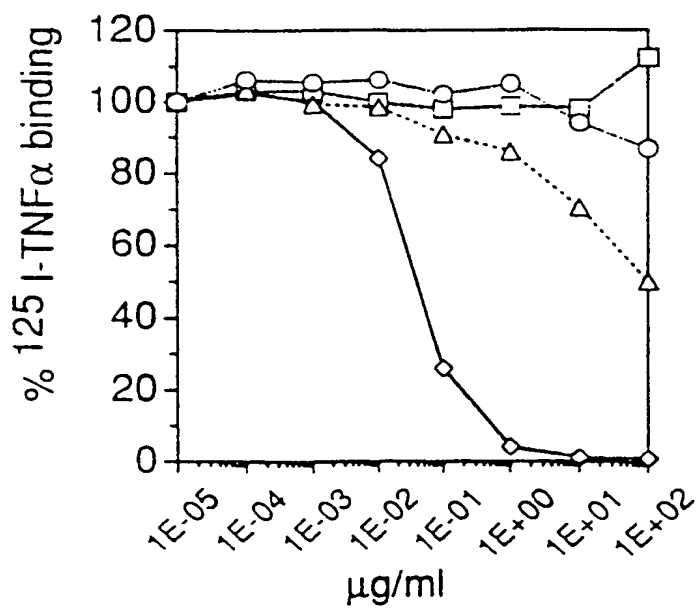


FIG. 4

TNFR-p75



TNFR-p55





European Patent
Office

PARTIAL EUROPEAN SEARCH REPORT Application Number
which under Rule 45 of the European Patent Convention EP 94 10 4154
shall be considered, for the purposes of subsequent
proceedings, as the European search report

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cls)
X	PROTEIN ENGINEERING vol. 4, no. 4, April 1991, ENGLAND GB pages 385 - 389 C. R. GOH ET AL 'Structural and functional domains in human tumour necrosis factors' * the whole document especially table I * ---	1-7	C12N15/28 C12P21/02 C07K13/00 A61K37/02 G01N33/68 C12N1/21
D,X	EP-A-0 168 214 (GENENTECH, INC.) * page 63, line 25 * ---	1-4, 9-13, 15, 16	
D,X	EP-A-0 251 037 (DAINIPPON PHARMACEUTICAL CO., LTD.) *the whole document especially the claims, example 9, page 42 lines 29-31, page 44 lines 1-6, page 25 table 5 * ---	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			C07K C12N
INCOMPLETE SEARCH			
<p>The Search Division considers that the present European patent application does not comply with the provisions of the European Patent Convention to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of some of the claims</p> <p>Claims searched completely : Claims searched incompletely : Claims not searched : Reason for the limitation of the search:</p> <p>see sheet C</p>			
Place of search THE HAGUE		Date of completion of the search 12 July 1994	Examiner Le Cornec, N
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- A : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			



European Patent
Office

PARTIAL EUROPEAN SEARCH REPORT

Application Number

EP 94 10 4154

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 5)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	<p>PROTEIN ENGINEERING</p> <p>vol. 3, no. 8 , August 1990 , ENGLAND GB</p> <p>pages 713 - 719</p> <p>JUN-ICHI YAMAGISHI ET AL 'Mutational analysis of structure-activity relationships in human Tumour Necrosis Factor-alpha'</p> <p>* the whole document *</p> <p>---</p>	1-4	
P, X	<p>JOURNAL OF BIOLOGICAL CHEMISTRY</p> <p>vol. 268, no. 35 , 15 December 1993 ,</p> <p>BALTIMORE, MD US</p> <p>pages 26350 - 26357</p> <p>H. LOETSCHER ET AL 'Human Tumour Necrosis Factor-alpha(TNF-alpha) mutants with exclusive specificity for the 55-kDa or 75-kDa TNF receptors'</p> <p>* the whole document *</p> <p>-----</p>	1-7	<p>TECHNICAL FIELDS SEARCHED (Int. Cl. 5)</p>



EP 94 10 4154

-C-

Remark: Although claim 16
is directed to a method of
treatment of (diagnostic method
practised on) the human/animal body
(Art. 52(4) EPC) the search has been
carried out and based on the
alleged effects of the compound/
composition